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STUDIES IN HUMAN INHERITANCE

XXII. THE INHERITANCE OF CONGENITAL PYLORIC STENOSIS

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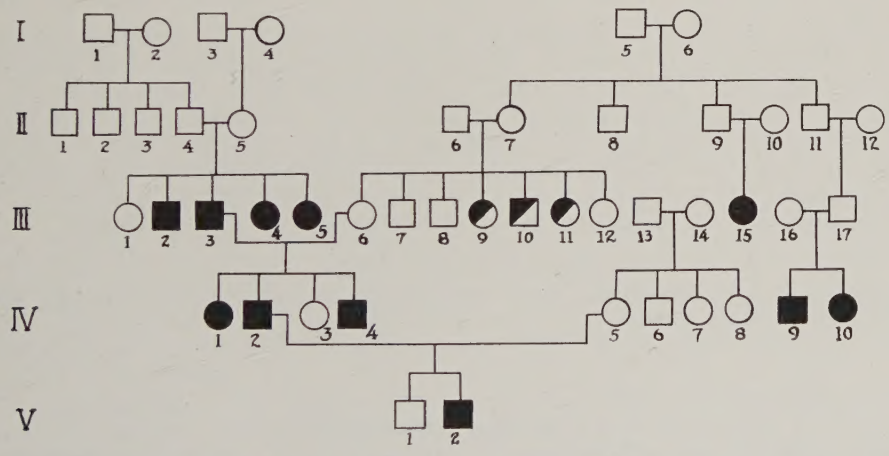
In a recent issue of this Journal (Vol. XXXIV, No. 1, Jan., 1943), Cockayne and Penrose discussed the genetics of congenital pyloric stenosis. They concluded that the condition is a recessive diathesis, that males are more susceptible than females, and that the first-born child is more susceptible than children born afterwards in the same sibship. In the recorded cases Cockayne and Penrose find a low familial incidence and relatively few pedigrees containing more than one affected child.



Pedigree of congenital pyloric stenosis:

III—2, Died of pyloric stenosis at 5 months. 3, Recovered from pyloric stenosis. 4, Died of pyloric stenosis at 5 months. 5, Died of pyloric stenosis at one day. 9, Died at two months, cause undetermined. 10, Died at three days, cause undetermined. 11, Born dead. 15, Died in infancy of pyloric stenosis.

IV—1, Died of pyloric stenosis at 8 days. 2, Recovered from pyloric stenosis; father of propositus. 4, Died of pyloric stenosis at 9 months. 9, Died of pyloric stenosis in infancy. 10, Recovered from pyloric stenosis.

V—2, Propositus; operated on for pyloric stenosis; recovered.

There has recently come to my attention a pedigree of congenital pyloric stenosis which provides interesting additional data (figure 1). The diagnosis of the propositus (V, 2) was confirmed at operation. The diagnoses of all other affected members were made on the basis of similarity of symptoms, which are very striking (projectile vomiting, constipation, gastric peristalsis, etc.).

Cockayne and Penrose recorded from their data a male to female ratio of six to one among affected cases. In the pedigree presented here there were six affected males and five affected females: no significant departure from equality. Moreover, Cockayne and Penrose state that on the basis of their data, a female who is not first-born stands very little chance of being affected. In the family under discussion here, however, only two of the five affected females were first-born, one was second-born, one was third-born and one was fourth-born.

Primogeniture has been suggested more than once as a contributing cause to congenital pyloric stenosis. The critical evidence necessary to establish this, namely, that children born after the patient are almost always normal, has never been produced. The pedigree herewith presented contains strong evidence against the causal nature of primogeniture. The birth orders of the affected children in figure 1 are as follows:

First-born: three, one of whom was an only child, one of whom was followed by one affected sib, and one of whom was followed by an affected sib, then by a normal sib, and finally by another affected sib.

Second-born: four, in two of which cases the first-born also was affected.

Third-born: one, in which case the first-born was normal, the second-born affected.

Fourth-born: two, in one of which cases the second-born and third-born also were affected, and in the other of which the first-born and third-born were similarly affected.

Fifth-born: one, in which case the second-, third- and fourth-born also were affected.

Cockayne and Penrose recorded an increased tendency to hare-lip and cleft palate in the families of patients. In the family presented here, there were two cases of cleft palate, namely II, 8 and a third cousin of IV, 4 not shown in the chart. No consanguineous marriages occurred in the pedigree shown in figure 1.

The data presented here are consistent with the hypothesis that congenital pyloric stenosis is due to an autosomal recessive gene substitution, but these data do not support the contention that primogeniture is a contributing cause, nor do they support the conclusion that males are more susceptible than females.

LITERATURE CITED

Cockayne, E. A., and **L. S. Penrose.** 1942. The Genetics of Congenital Pyloric Stenosis. Ohio Journal of Science, 43: 1–16.

Parasites of Humans

Will Rogers once wrote Will Durant that there seems to be no way to keep people from writing books. But if the high quality of the flood of textbooks in parasitology continues, even more of them will be welcome. Americans are rapidly becoming "parasite conscious" as American citizens are going to all parts of the world and to many places famous for diseases caused or transmitted by animal parasites.

This latest book is a brief account of important human animal parasites and the diseases they cause. There are two sections: one is general considerations and the other is infections caused by protozoa, flukes, tapeworms, nematodes, and arthropods. The information is modern and written so that very little zoological information is required of the reader. The illustrations are a departure from what might be anticipated in that most of them are photographs. The part, of slightly more than fifty pages, dealing with infection, epidemiology, natural resistance and acquired immunity, diagnosis, specific therapy, and prophylaxis, deserves special mention, for these topics are handled in superb fashion. The entire book is of high quality in content and appearance and is intended for medical students and physicians.—*Carl E. Venard.*

Medical Parasitology, by James T. Culbertson. xvi+285 pages, Columbia University Press, Morningside Heights, New York. Sept., 1942. Price, $4.25.

STRUCTURE AND RELATIONSHIP OF CINCINNATIAN CYRTOCERINA

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INTRODUCTION

None of the three species currently referred to the genus *Cyrtocerina* Billings have been subjected to more than a superficial morphological examination. The present work deals with the investigation of *Cyrtocerina madisonensis* (Miller) formerly regarded as the only representative of the genus in the Cincinnatian. The specimens which have been included under that name in the collection of the University of Cincinnati Museum, and which form the basis of this study, proved on examination to include four species, three of which were closely related and evidently typical of *Cyrtocerina*. The fourth species, externally homeomorphic with *Cyrtocerina*, is referred with question to *Wetherbyoceras* Foerste, though as pointed out below, it probably represents a separate but allied genus now in process of description on the basis of better preserved Chazyan material.

These taxonomic details completed, there remains the more fascinating problem of the structure and affinities of *Cyrtocerina* itself. The vestigial septal necks and the inflated connecting rings are features which at once proclaim the relationship of this genus with some of our earliest cephalopods, those previously placed by the writer (1941), in the Eurysiphonata of Teichert (1933). As these forms are still rather inadequately known, it is not possible to determine the relationship of *Cyrtocerina* very precisely. It differs from all other post-Canadian genera in internal structure, and is quite probably related to *Levisoceras* Foerste, a genus which has not as yet been studied as closely as is desirable for comparison with *Cyrtocerina*. Ulrich and Foerste (1933) have referred *Levisoceras* to the Diphragmida, a group of cephalopods found in the Gasconade and earlier strata, and characterized by diaphragms or tabulae which cross the cavity of the siphuncle. *Cyrtocerina* clearly possesses no such tabulae, but if *Levisoceras* is properly placed in the Diphragmida, as seems probable from the meagre published evidence, *Cyrtocerina* is the only post-Canadian genus which can be traced directly to that group of cephalopods.

I am indebted to Mr. Clifton Smith, student assistant in the University of Cincinnati Museum, for assistance in the preparation of photographs. The expense of illustrative materials as well as part of the cost of the plates has been met by the Faber Publication Fund of the University of Cincinnati Museum.

Cyrtocerina Billings

Genotype: *Cyrtocerina typica* Billings

Cyrtocerina Billings, 1865, Pal. Foss., Geol. Surv. Canada, p. 178.
Barrande, 1867, Syst. Sil. de centre de la Boheme, vol. 2, pt. 1, p. 451.
Hyatt, 1884, Boston Soc. Nat. Hist., Proc., vol. 22, p. 266.
Miller, 1889, N. Amer. Geol. Pal., p. 436.
Holm, 1892, Geol. Foren. Stockholm, Forh., vol. 14, pp. 126, 209.
Clarke, 1897, Geol. Minnesota, vol. 3, pt. 2, p. 774.
Hyatt, 1900, Zittel-Eastmann Textb. Paleont., vol. 1, 1st ed., p. 517. (Reprinted with different pagination in later editions.)
Foerste, 1924, Denison Univ. Bull., Sci. Lab., Jour., vol. 20, p. 198.
Foerste, 1925, *Ibid.*, vol. 21, p. 11.
Foerste, 1933, *Ibid.*, vol. 28, p. 138.

Conch a rapidly expanding short cyrtoceracone, the aperture uncontracted. Section compressed, the convex dorsal (antisiphonal) side frequently obscurely angulate. Sutures are straight and transverse. The siphuncle is located close to the concave side of the conch, generally assumed to be ventral in such cephalopods. The siphuncle itself expands rapidly, being conical in form. The septal necks are vestigial, the connecting rings thickened and more or less produced into the cavity of the siphuncle in each segment. Their complex structure is described in the morphological section of the present work. The aperture has not been observed. Coarse rugose lines of growth indicate that there is no hyponomic sinus developed.

Discussion.—The short rapidly expanding endogastric conch of this Ordovician genus is not closely similar to that of any contemporaneous form, but instead is similar to *Levisoceras* and perhaps also comparable to *Shelbyoceras* of the Upper Cambrian and Basal Ordovician. Those genera are regarded as possessing diaphragms crossing the cavity of the siphuncle. No post-Canadian genera are known which are strictly comparable. On the basis of the exterior alone, *Cyrtocerina* might be confused with immature fragments of *Diestoceras*, but study of the interior will at once show the difference, as *Diestoceras* is cyrtochoanitic and actinosiphonate. The species described below as *Wetherbyoceras? cyrtocerinoides* Flower, n. sp. is similar to *Cyrtocerina* in aspect, but this is also cyrtochoanitic. Both *Wetherbyoceras* and *Diestoceras* can be distinguished not only by the difference in the structure of the siphuncle, but also by the relatively deep camerae, even in small fragments of early parts of the conchs of any known representatives of these genera.

Billings erected *Cyrtocerina* for the reception of short rapidly expanding conchs which were characterized by a large siphuncle on the dorsal (concave) side of the shell. Besides the genotype, *C. typica*, from the Middle Ordovician of the Paquette Rapids of the Ottawa River, he included in it *Cyrtocerina mercurius* Billings (1865, p. 193, fig. 179) of the Quebec group. Miller and Faber (1894) referred to the genus a species previously described as *Tryblidium madisonense* Miller from the Hitz layer, of Whitewater age, at Madison, Indiana. Clarke (1897), added *Cyrtocerina schoolcrafti* from the Decorah formation of Black River age of Minnesota. Foerste (1925) separated *C. mercurius*, making it the type of the new genus *Levisoceras* which he states is "apparently holochoanoidal in structure" while *C. typica* "is distinctly an ellipochoanoidal species." This was written at a time when Foerste regarded all Canadian or older cephalopods as holochoanitic, a view which he abandoned upon further investigation. Ulrich and Foerste (1933, p. 289), later reported that the necks of *Levisoceras* were *aneuchoanitic*, that is, terminating at the margin of the siphuncle with only vestigial curvature apicad, and that the interior of the siphuncle contained diaphragms. Upon this basis they placed *Levisoceras* in the Diphragmida. As shown below, *Cyrtocerina* is now known to agree closely with *Levisoceras* both in the form of the septal neck and the general appearance of the connecting ring, but clearly it does not possess diaphragms.

Cyrtocerina differs from all other post-Canadian cephalopods in the rapidly expanding form of the shell, the compressed section, and the position of the siphuncle close against the concave side of the shell. There is as yet no good criterion to show whether the siphuncle is dorsal in position as Billings assumed in writing the original description of the genus, or whether the conch has been curved endogastrically, so that the concave side is ventral, as Foerste believed, I have, in the following descriptions, retained Foerste's orientation, though out of regard to current usage rather than out of any conviction on the matter. The lines of growth of the surface fail to show any evidence of a hyponomic sinus by which the venter may be determined. No specimens have been found yielding either the ventral conchial furrow or the dorsal septal furrow which may be regarded as reliable criteria of orientation. (Flower, 1939, pp. 13–16.)

Knowledge of the internal structure of *Cyrtocerina* is based exclusively upon the Cincinnatian species discussed below, notably upon *C. madisonensis* (Miller) and *C. modesta* Flower. While there is every reason to believe that the genotype is similarly constructed, the conditions under which it is preserved are not favorable for the study of structural details. *C. typica* is apparently a very rare species. It is known to the writer only from Billings' type, which is preserved in the collections of the Victoria Memorial Museum at Ottawa. This is an exceedingly fragile silicified specimen from which all matrix has been removed by careful etching.

In all essential features it agrees with the Richmond species insofar as they can be observed. The large conical siphuncle is close to the concave side of the conch. Its interior presents a faintly annulated appearance. In considering this form as ellipochoanitic, Foerste probably regarded the constrictions as representing the septal foramina. However, in the light of the structure of *C. madisonensis*, it seems much better to regard the constrictions as the connecting rings which are produced in an annular manner into the cavity of the siphuncle. Even should material of the genotype be available which was contained in matrix and suitable for sectioning, it is to be feared that little more could be learned. Shells in that limestone are extensively replaced by silica. While this makes possible the removal of remarkably perfect specimens by means of etching, it has so altered original shell structure that thin section study of the material is profitless, and often opaque sections fail to show structures clearly.

Cyrtocerina is unknown in strata older than the Black River. *C. schoolcrafti* Clarke occurs in the Decorah formation of Black River age in Minnesota. *C. typica*, of the Paquette Rapids, occurs in a limestone which was formerly regarded as Black River age. Kay, however, regards the beds as belonging to the Rockland, lower Trenton, though his reasons for doing so have not been published. The genus is unknown in strata of higher Trenton or Covington age, and reappears only in the Whitewater formation near the top of the Richmond of Indiana. The three Richmond species, *C. madisonensis* (Miller) *C. patella* Flower and *C. modesta* Flower are best developed in the "Hitz layer," the southward thinning edge of the Upper Whitewater strata just above the Saluda beds at Madison, Indiana. One specimen was collected by the writer in the Whitewater strata at Versailles, Indiana. No representatives of the genus are known occurring either farther north or east.

This distribution suggests that *Cyrtocerina* belongs to that group of genera which appeared in eastern North America in Middle Ordovician time, then disappeared, presumably to arctic waters, to reappear in the east only near the close of the Richmond. The genus has not yet, however, been found in any of the strata laid down within the Late Ordovician Arctic embayment.

Cyrtocerina madisonensis (Miller)

(Pl. 1, figs. 3–4, 12–14; pl. 2, figs. 1, 3–7, 9.)

Tryblidium madisonense Miller, 1894 (adv. sheets, 1892) 18th Rep. Indiana Dept. Geol. Nat. Res., p. 318, pl. 9, fig. 38.
Cyrtocerina madisonense Miller and Faber, 1894, Cincinnati Soc. Nat. Hist., Jour., vol. 17, p. 32.

Original description.—"Shell medium size; apex high and almost straight above the anterior line of the shell; the shell slopes from the apex and arches a little toward the posterior part of the shell, but laterally and in front it descends abruptly to the margin; transverse section ovate; surface marked with fine, close, concentric lines and a few coarser ones, all of which appear to indicate lines of growth, instead of surface ornamentation; internal scars unknown.

The high apex and anterior portion of it seem to distinguish this species.

Found by J. F. Hammell, in the Hudson River Group, at Madison, Indiana, and now in his collection."

As can be seen, the *Cyrtocerina* was at first described in terms of a *Tryblidium*, a not unnatural error in dealing with a specimen of this peculiar cephalopod genus which failed to show any trace of the phragmocone. However, subsequent specimens showing the phragmocone caused Miller and Faber to revise the original description. Their revised description is quoted, as upon it depends the problem as to the exact identity of *Cyrtocerina madisonensis:*

"At the time one of the authors described, for the Eighteenth Indiana Report (Adv. Sheets Eighteenth Rep. Geo. Sur. Ind., p. 64) a fossil under the name of *Tryblidium madisonense* the internal part of it was not disclosed by the specimen at hand, while the external shell was remarkably well preserved and looked like that of a gastropod, and the form was that of a rather high Tryblidium. There was nothing in the shape or external appearance that would create the slightest suspicion that it belonged to the Cephalopoda. After that time specimens were collected showing a short, very rapidly tapering siphuncle, terminating on the concave

side, below the apex and occupying the same position as the siphuncle in Cyrtocerina. Prof. Geo. C. Hubbard was the first to find that it was a chambered shell and possessed a siphuncle, and an examination of his specimens by the author led him to the conclusion that it is a true Cyrtocerina. The chambers are short, though longer than they are in *Cyrtocerina typica*, and the shell expands somewhat more rapidly than it does in that species.

"Heretofore there have been only two species known in this genus. The oldest, *Cyrtocerina mercurius*, from the Taconic rocks, the most elongated species and having the shorter septa, and *Cyrtocerina typica*, from the Black River Group. The species here under consideration is from the extreme upper part of the Hudson River group, which gives a range to this genus, commencing below the Silurian rocks and extending to the very top of the Silurian system."

Previously only this one Cincinnatian species of *Cyrtocerina* has been recognized, a species which marks the upper Whitewater beds above the Saluda, and is typically known from Madison, Indiana, though I have collected it as far north as Versailles, Indiana. Examination of the specimens that had been included under this name revealed that two genera were involved. One of these was characterized by the conical siphuncle noted in the description of Miller and Faber, and agrees closely with the original and revised descriptions. It was evident then, that *C. madisonensis* was among those forms which possessed a siphuncle similar to that of the genotype of *Cyrtocerina*. However, even among these specimens three distinct groups were recognizable on the basis of section and rate of expansion of the shell. Had there been but two, I should have been tempted perhaps to regard them as sexual dimorphism within a single species. However the three forms are sufficiently distinct to describe them as distinct species. The problem then arose as to which of these is identical with the original of *Cyrtocerina madisonense*, the type of which I was not able to locate. Fortunately the original description and figure furnish data by which this matter can be settled beyond any reasonable doubt. The ventral (siphonal) side of the conch must be straight or nearly so; the antisiphonal side must be curved, the curvature increasing as the aperture is approached. On this basis it is quite simple to select among the three species the one which was almost certainly the original of *C. madisonensis*. *C. patella* is a much larger form and one which expands more rapidly throughout. *C. modesta* is a much more slender form in which the curvature of the antisiphonal side is nearly uniform throughout, and in which the section is not nearly as compressed as in either of the other two associated species.

Revised description.—Conch rapidly expanding, compressed in section, the dorsal (antisiphonal) side faintly convex in the early portion, later becoming more curved, so that the rate of expansion decreases orad. The ventral (siphonal) side is nearly straight, probably slightly concave in the extreme apical portion, and becomes very faintly convex as the gerontic camerae are approached. The best preserved of our specimens has an initial height of 4 mm., expands to 25 mm., in the basal 12 mm., beyond which the increasing convexity of the siphonal side reduces the rate of expansion. At a height of 29 mm. the shell has a width of 25 mm. The lateral outlines are slightly convex; the section is compressed with the antisiphonal side the narrower of the two, obscurely angulate, and ridged when viewed adaipcally. The living chamber is very imperfectly known.

The septa are very closely spaced throughout the conch, the sutures tend to slope orad on the antisiphonal side as the aperture is approached. The siphuncle is conical, 1 mm. in diameter where the shell height is 10 mm; and 8 mm. at a shell height of 36 mm. The siphuncular structure is described in detail in another section of this paper.

Types.—Hypotypes, University of Cincinnati Museum, nos. 23965, 23966.

Occurrence.—From the Hitz layer of the Whitewater formation of the Richmond, from Madison, Indiana.

Cyrtocerina patella Flower, n. sp.

(Pl. 1, figs. 1, 5, 8.)

This shell is very rapidly expanding initially, and the convexity of the antisiphonal side increases only slightly, and at a much later stage than in *C. madisonense*. The conch expands in the basal 11 mm. to 24 mm. and 21 mm., the venter (siphonal side) straight, the dorsum only

faintly convex, and the lateral outlines straight and rapidly diverging. A second specimen, consisting of a portion of a mature living chamber and gerontic camerae expands from 22 mm. and 25 mm. to a width of 40 mm. and an estimated height of from 45 mm. to 48 mm. in a length of 23 mm. The aperture is not preserved.

The phragmocone shows no features strikingly different from those of the above species. The camerae are exceedingly closely spaced gerontically, eight or nine occurring in the last 5 mm. of the siphuncle. The siphuncle is conical, close to the concave side of the shell. At conchial diameters of 22 mm. and 25 mm. it is 4.8 mm. wide and 5.2 mm. high.

Types.—University of Cincinnati Museum, Holotype, No. 23967, paratypes, No. 2638, 23968, 23969.

Occurrence.—The holotype is from the upper beds of the Whitewater formation from the road cut just east of the limits of Versailles, Indiana. The paratypes are from Madison, Indiana.

Cyrtocerina modesta Flower, n. sp.

(Pl. 1, figs. 2, 6–7; Pl. 2, figs. 2, 8.)

This species differs from the associated *C. patella* and *C. madisonensis* by its much more slender form and broader section. The ventral side is obscurely flattened, the dorsum obscurely ridged. The dorsal profile is slightly and evenly convex throughout, the venter is slightly convex, though nearly straight. The conch increases to a width of 22 mm. and a height of 24 mm. at a distance of about 23 mm. from the apex. At comparable distances from the initial point, both other species have sections both higher and broader. The lateral outlines are slightly and uniformly convex like those of the dorsum and venter. The siphuncle is close to the venter. The camerae are possibly slightly deeper than those of the other species. The form of the conch is best recognized from the accompanying illustrations.

Discussion.—The three specimens upon which this species is based vary somewhat in proportions, owing largely and perhaps entirely to distortion. One specimen is slightly compressed by pressure, but slightly obliquely compressed, so that the tip of the siphuncle is exposed by weathering on one lateral surface.

Types.—University of Cincinnati, No. 17170, holotype; No. 23970–71, paratypes.

Occurrence.—From the Hitz layer of the Whitewater formation, Madison, Indiana.

Wetherbyoceras? cyrtocerinoides Flower, n. sp.

(Pl. 1, figs. 9–11.)

Associated with the species of *Cyrtocerina* described above, is a small portion of a phragmocone which resembles members of that genus very closely in rapid expansion, the apparent endogastric position of the siphuncle, and the development of a compressed antisiphonal side. Nevertheless, sections revealed that the siphuncle was cyrtochoanitic, and that this specimen represents a hitherto unrecognized species. Probably also it represents an undescribed genus, though one which is known to the writer from other material, and is related to *Wetherbyoceras* Foerste, to which I tentatively refer this form.

The conch is compressed initially, with dorsum and venter equally rounded, with a hieght of 21 mm. and a width of 16 mm. In a siphonal length of 16 mm. and an antisiphonal length of 18 mm., the conch increases to a height of 33 mm. and a width of 29 mm. The greatest width of the shell is attained ventrad of the center of the section, and the dorsal (antisiphonal) side is much narrower than the siphonal side. All profiles of the conch are straight. The antisiphonal side is more strongly inclined from the line normal to the plane of the septa than is the siphonal side, giving the shell an endogastric aspect.

Five camerae and part of a sixth are preserved. The septa are shallow, the sutures apparently straight and transverse. The marginal siphuncle is crytochoanitic, the segments broadly expanded, rounded, strongly assymetrical vertically, as in many cephalopods with marginal siphuncles. The apical end of the connecting ring is broadly adnate to the septum on the ventral side, but free dorsally. At the adoral end of the segment, expansion is more marked

on the dorsal than on the ventral side, but the brims are short and free on both sides. Small annulosiphonate deposits are found within the siphuncle. No trace of actinosiphonate structure is shown on this specimen. The surface of the shell is unknown.

Discussion.—This fragmentary specimen is very similar in aspect to one which Foerste figured and described as *Ooceras?* sp. from the Whitehead formation of Gaspé (Foerste, 1936, p. 381, Pl. 56, fig. 9.) The two species are almost certainly congeneric. Foerste remarked upon the similarity of his form with *Ooceras seelyi* and *O. lativentrum* as figured by Ruedemann (1906, pp. 496–499, Pl. 38, fig. 7–9). These species form the nucleus of a considerable group of Chazyan species for which a new generic name will be proposed at another time. These cephalopods are characterized by organic deposits within the siphuncle which may be apparently annulosiphonate in small or immature individuals. Some species never pass beyond the annulosiphonate stage, but large species finally attain deposits which are actinosiphonate and strongly reminiscent of *Minganoceras* Foerste (1938, pp. 104–5, Pl. 24, fig. 1–4). This genus appears again in the Platteville limestone, but does not appear again in the American section until found in the Whitewater formation of Indiana and the Whitehead formation of Gaspé. However, subsequent study of the little known genus *Wetherbyoceras*, the living chamber of which is still unknown, has shown that that genus is closely related to this one, so I tentatively refer the species to that genus. This does not, however, imply that *W? cyrtocerinoides* is at all closely related to either *W. valandighami* or *W. conoidale*, which are Covington species. The peculiar type of preservation of the deposits noted by Foerste in his species and in the Chazyan forms also, is not as startlingly displayed in the Cincinnatian species. There is, however, some indication of this mode of preservation in our specimen, which is not confined to the genus, but is widespread among fundamentally actinosiphonate cephalopods and has been noted by the writer in *Diestoceras*, *Cyrtacleistoceras*, *Minganoceras*, and *Archiacoceras*.

Type.—Holotype, University of Cincinnati Museum, No. 23971.

Occurrence.—Hitz layer, Upper Whitewater, Richmond group. From Madison, Indiana.

STRUCTURE OF THE SIPHUNCLE OF CYRTOCERINA

Opaque sections (Pl. 1, fig. 13, pl. 2, fig. 5) show that the siphuncle expands rapidly within the conch, taking on a conical form. The septal necks appear to be very short or wanting, and the interior of the siphuncle appears to be lined with an annular deposit. This differs from the usual annulosiphonate deposits in that the cavity of the siphuncle is constricted at the middle of each segment of the siphuncle, whereas normal annulosiphonate structure causes the constrictions to be located at the level of the septal foramina.

The same specimen in thin section (Pl. 1, fig. 12, 14; Pl. 2, fig. 1, 3, 4, 6, 7, 9) shows that the structure is quite unlike that of any known contemporaneous cephalopod. The septa are properly aneuchoanitic, that is, they terminate at the

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EXPLANATION OF PLATE I

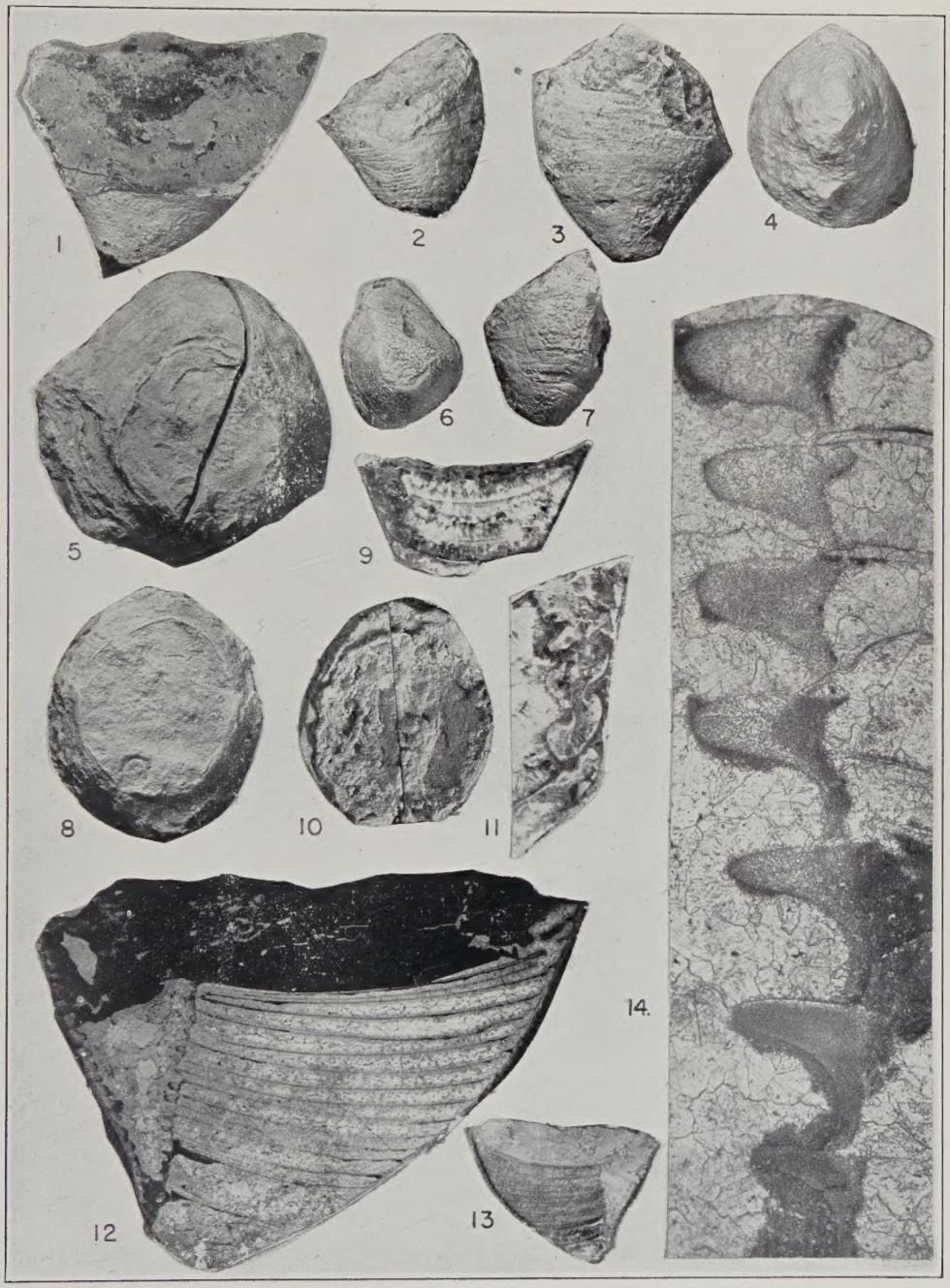
Cyrtocerina patella, Flower, n. sp. (1) Composite specimen showing vertical section of holotype (No. 23967) adorally, and unsectioned paratype adapically (No. 2368). (5) adapical view of holotype. (8) adapical view of paratype, No. 23968. Upper Whitewater formation. Holotype from Versailles, Indiana, other specimens from Madison, Indiana.

Cyrtocerina modesta Flower, n. sp. Paratype, No. 23970, Upper Whitewater formation, Madison, Indiana. Lateral (2), adapical (6), and dorsal (7) aspects.

Cyrtocerina madisonensis (Miller) lateral (3) and adapical (4) views of hypotype No. 23966. Madison, Indiana.

Wetherbyoceras? cyrtocerinoides Flower, n. sp. (9) vertical section, (10) adoral view, and (11) enlargement of siphuncle showing annulosiphonate deposits, of holotype, No. 23971. Upper Whitewater, Madison, Indiana.

Cyrtocerina madisonensis (Miller). Hypotype, No. 23965. (12) thin section, ×2½; (13), opaque section of the same specimen, ×1; (14), enlargement of dorsal wall of siphuncle from middle part of specimen, about ×18.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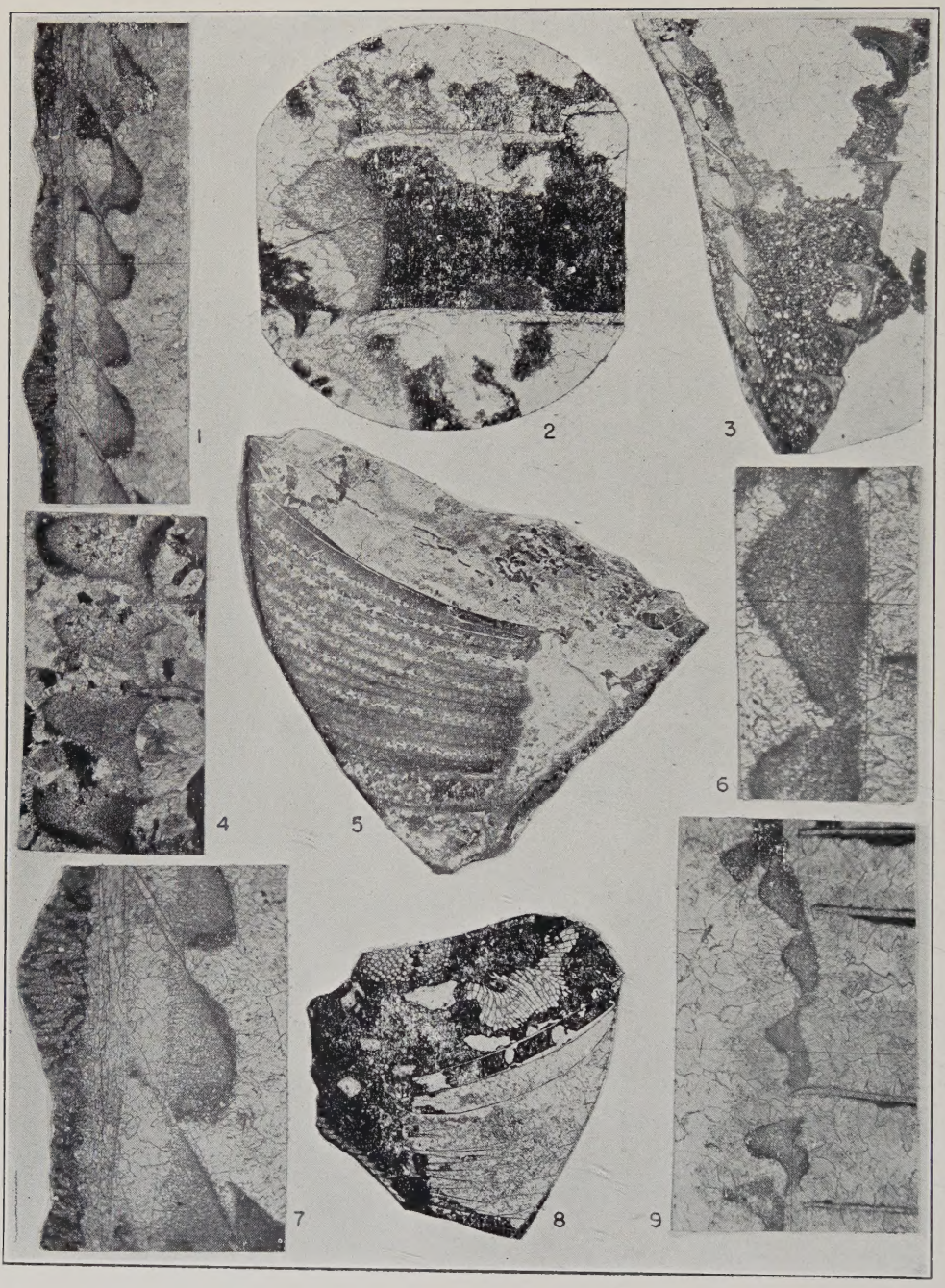
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margin of the siphuncle either without bending apicad at all, (Pl. 1, fig. 14, pl. 2, fig. 4, also figs. 1 and 7) or else there is only a vestige of a neck (Pl. 2, fig. 2). The structures which appeared in opaque section to represent accessory deposits, are revealed as curiously thickened connecting rings, rather variable in shape and composition, which are more or less produced into the cavity of the siphuncle. Both the thickness of the rings and the tendency for different regions to show structural variations, are reminiscent of the structures previously reported by the writer (Flower, 1941), as characterizing the older and more generalized of the Eurysophonata.

As structures and forms of the connecting rings vary somewhat from dorsum to venter, the two sides of the siphuncle are best discussed separately. The ventral side of the siphuncle is shown in Pl. 2, fig. 1, and a further enlargement of the apical portion of this figure is illustrated in Pl. 2, fig. 7. Traces of the mural part of the septum can sometimes be made out against the wall of the conch, but it is rarely possible to determine whether it extends forward for the entire length of the camera or not. The free part of the septum is straight, strongly inclined apicad, and terminates without any modification which could be construed as a true neck. The upper of the two septa shown in Pl. 2, fig. 7 is retouched to bring out its outline. The other is unmodified from the original.

The connecting rings are more or less semi-oval, the siphonal side convex, while the cameral side is usually straight, though, as seen in the uppermost segment of Pl. 2, fig. 1, it may occasionally be concave. The ring is divisible into two parts. On the siphonal surface one part appears as a thin dark band, sometimes more or less irregularly swollen in places. This contrasts strongly with the broader lighter area on the cameral surface. The condition is superficially similar to that noted in the aneuchoanitic *Proterocameroceras* (Flower, 1941, Pl. 1, figs. 3–5), but closer inspection shows that while zones of similar proportion occur in *Proterocameroceras* the contact between them is sharp. Here it is gradational.

The entire connecting ring contrasts strongly with the septa, the wall of the shell, or infiltrated calcite occupying the cavities of the camerae or siphuncle, in its fine grained texture. Examination of the connecting ring under high power shows that it is made up of very minute granules, probably crystals of calcite. If one traces the fine structure from a light to a dark portion of the ring it will be seen that the opacity of the siphonal surface is due to the presence there of closely packed minute granules, while in the lighter areas the grains are larger. The difference in appearance of the two regions is due to texture, and not to any pigment. The dark siphonal margin is very similar in appearance to the matrix within which the shell was buried, and in portions where the connecting ring is in

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EXPLANATION OF PLATE II

Cyrtocerina madisonensis, No. 23965. (1) Dorsal wall of siphuncle, septa and shell wall, about ×8, showing variation in form and appearance of connecting ring. (3) Adapical portion of section, showing invasion of matrix from broken apex of siphuncle, and modification of replacement of connecting rings in contact with matrix. ×8. (4) Dorsal wall of siphuncle, ×10, crossed nicols. Note coarse crystaline matrix and fine crystaline granules of connecting rings. Coarse crystals are seen in the second ring from the top only, evidently an alteration phenomenon. (5) Opaque section of same specimen, about ×2½. (6) Adoral dorsal connecting rings, about ×35, showing gradation of size of granules between light and dark areas. (7) Enlargement, about ×26, of dorsal wall of siphuncle, the adapical, portion of fig. 1. The outline of the upper septal neck is retouched. (9) Adoral dorsal siphuncular segments showing different form of segments, and distortion of conch, whereby a neck is apparently developed on the second septum from the top of the figure.

Cyrtocerina modesta Flower, n. sp. Holotype, No. 17170, Upper Whitewater, Madison, Indiana. (2) Adoral segment of dorsal wall of siphuncle showing form of ring, unusually well bent neck, and an abnormal bend in the septum in the upper right side of the photograph, ×22. (8) Vertical section complete, × 2½.

contact with matrix, it is very difficult to determine the boundary between the dark siphonal margin and the fine grained faintly dolomitic lime mud. This is shown, though somewhat obscurely, in Pl. 2, fig. 3, which shows the apical end of the siphuncle of our specimen. The extreme tip is missing, and matrix has entered through the broken end. However, the organic nature of the siphonal lining is shown clearly in more adoral segments, for it is well developed there in regions where matrix never penetrated. Quite probably this shell was buried at a time when some tissue still occupied the siphuncle. Matrix is present in the living chamber and has entered a little way into the siphuncle from either end. The greater part of the cavity of the siphuncle is occupied by calcite which has a sharp contact with the invading mud. This is believed to be one example, of which several others have been noted, of calcite representing the position of tissue present at the time of burial of a cephalopod shell.

The textural modifications of the connecting ring were plainly original, and indicate probably the deposition of the connecting ring as fine calcite granules of crystaline nature. These have been less susceptible to replacement and alteration than have the originally aragonitic shell parts. However, they have suffered some alteration, as can be seen when they are viewed through crossed nicols. Under such conditions (Pl. 2, fig. 4), the majority of the connecting rings are seen to be made up of fine granules, each of which has its own optical orientation so that at one position no two adjacent crystals ordinarily attain extinction. This causes the connecting rings to stand out strikingly against the large and irregular calcite crystals of the septa and of the infiltrated calcite in the shell cavities. However, this figure shows a number of areas in which recrystallization has taken place, notably in the upper two connecting rings, so that the granules are replaced by large irregular crystals. No trace of this phenomenon can be seen in ordinary light however, and the original granular structure seems to hold throughout under such conditions. This can be seen by comparing Pl. 2, fig 4 with the upper four segments shown in greater enlargement in Pl. 1, fig. 14. These phenomena indicate that both zonation and the granular nature of the connecting ring were probably original.

The dorsal side of the siphuncle shows the septa terminating ordinarily with no trace of a neck, but instead of sloping apicad throughout their length, they are essentially straight and transverse. This is shown most clearly in Pl. 1, fig. 14, and Pl. 2, fig. 4. Near the adoral end of the specimen (Pl. 2, fig. 8) an interesting condition is shown in which very short necks appear to be developed by abrupt bending. This part of the shell is slightly distorted, and the connecting rings have been moved out of line, and shoved slightly apicad from their original positions. Possibly the same force has been responsible for the bending of the tips of the septa, for the structure is irregular and far from uniform.

The nearest approach to a neck is shown in the adoral septum of the holotype of *Cyrtocerina modesta* (Pl. 2, fig. 2). Here the neck is faintly recurved. However, this specimen shows an abrupt bend in the septum before the siphuncle is attained, shown in the upper right corner of our photograph, which has been observed nowhere else and is probably due to injury. It is possible that injury may have affected the general organization of the shell enough to produce a slightly greater bending at the tip of the septum as well, so it is not certain that this condition is normal.

The connecting rings on the dorsal side of the siphuncle are more or less triangular in shape. The most typical form is shown in a series taken from the middle of Pl. 1, fig. 12, shown in Pl. 1, fig. 14. The ring is subtriangular, the cameral side straight or faintly concave, the siphonal side strongly produced, and extending farthest into the siphuncle at its adoral end. Farther orad in the siphuncle of the same specimen, (Pl. 2, fig. 9), the rings do not project as far into the siphuncle, and the greatest width is near the middle of the ring rather than at its adoral end.

The comma shaped ring of *C. modesta* (Pl. 2, fig. 2) may be diagnostic of the species, but enough segments have not been seen in which the connecting rings were preserved to make this certain.

The series of segments shown in Pl. 1, fig. 14 show the maximum variation noted in texture and mode of preservation of the rings on the dorsal side of the siphuncle. The upper three figures show the most typical condition. As on the ventral side, the greater bulk of the ring is made up of light, transparent, relatively large granules. The siphonal border consists of a more opaque area, again resembling matrix where it is most completely developed. As before, the two areas intergrade. The cameral surface of the ring shows a similar marginal opaque area. The simplest condition, showing the most gradual change from the central light area to the dark margin, is shown in the second segment from the top of our figure. In this the marginal opaque areas have not attained as great a development as in neighboring segments. The fourth segment from the top shows a curious darkening of a very broad band along the cameral surface. The next few segments are uniformly dark, a condition which is believed to be due to alteration connected in some manner with the invasion of sediments to these segments, as shown in Pl. 2, fig. 3. Rather strangely, segments which occur farther apicad in this series and which are more completely surrounded by matrix, show less modification. The second segment from the bottom of the same figure is unique among the rings observed in *Cyrtocerina* in that its siphonal surface appears to be marked by a thin line which seems to represent a definite wall. This sets off the main mass of the connecting ring from an irregular band of dark material resembling matrix, which in this case it probably is.

Interpretation of the structural significance of the various bands of the connecting ring of *Cyrtocerina* is still uncertain. Evidently the modification was original, for the same phenomena can be recognized, though differently preserved, under different conditions of alteration and replacement. The granular nature of the ring is what one might reasonably expect to be more widely found among fossil nautiloids if, as has been reported of *Nautilus*, their connecting rings are composed of fine crystals of calcite in contrast to the prismatic aragonite of the shell proper. The marginal opaque zones are of uncertain interpretation. Superficially, these bear a strong resemblance to various structures previously observed by the writer in eurysiphonate cephalopods. The eyelet reported in the tip of the connecting ring of several genera, notably among the Tarphyceratidae and in *Vaginoceras oppletum* (Flower, 1941), shows the same very fine grained condition, and the same degree of opacity as do these marginal zones. Similar also is the "inner zone" of the connecting ring on the siphonal surface in *Eurystomites*. Occasionally this and related genera have shown a similar zone on the cameral surface, but it was so faint that I did not at the time regard it as an original structure. Likewise the inner zone of *Proterocameroceras* is similar, though in that genus the zone is clearly set off from the remainder of the deposit, more strongly so than in any other form observed. The irregularity of the opaque material which lies along both the siphonal and cameral surfaces of the deposits, and which can also be seen occasionally against the septa in the camerae, is perplexing largely because of its irregularity. The most logical interpretation seems to be that this may represent vestiges of organic matter derived from tissues present in the camerae and siphuncle at the time of the burial of the conch.

RELATIONSHIP OF CYRTOCERINA

Hyatt (1883) originally placed *Cyrtocerina* with the Holochoanoidea, but later (1900) removed it to the Schistochoanites. That group, now no longer recognized, also contained the genus *Conoceras* Bronn of which Hyatt regarded *Bathmoceras* Barrande as a synonym. *Conoceras* is still very poorly understood, but *Bath-*

moceras appears to be a valid genus in which, as was shown by Holm (1899) processes from the wall of the siphuncle project centrad and orad into the siphuncle. These structures Holm figured as thickened connecting rings. So strong is the resemblance between these rings in *Bathmoceras* and the annulosiphonate deposits of *Polydesmia*, that it appears reasonably certain that *Bathmoceras* is ancestral to the Actinoceroidea. Further examination of this hypothesis showed that if this connection was real, the rings of *Bathmoceras* must be relatively complex. Though no differentiation of structure was shown by Holm, who worked only from opaque sections, it became evident that somewhere in the actinoceroid line there must have occurred a differentiation of the generalized part of the connecting ring and that part which was finally modified to form annulosiphonate deposits. This differentiation was one of material, for even in *Polydesmia* the deposits appear as structures quite distinct from the generalized part of the connecting ring. To eliminate this difficulty, it was suggested that the eyelet was the origin of the greater part of the mass of the deposit of *Bathmoceras*, and that the structure grew orad, finally thickening and sending a lobate process into the cavity of the siphuncle.

The connecting ring of *Cyrtocerina* is not unlike that of *Bathmoceras* in form. On the basis of outline alone the two could be homologized. However, the zonal development of the ring in *Cyrtocerina* is such as to indicate that either the genus must have some other relationship, or else that the structure of *Bathmoceras* is quite different from what Holm's figures and the strong resemblance to *Polydesmia* suggest. Further discrepancies are found in the form of the shells of the two genera, one a slender orthoceracone, the other a short endogastric brevicone. The genera further differ in the condition of the septal neck, *Cyrtocerina* having no true neck developed, while the necks of *Bathmoceras* are long and sometimes show more than a suggestion of cyrtochoanitic structure.

The siphuncle wall of *Cyrtocerina* shows, in the thickness and zoning of the connecting ring, features which the writer has taken as diagnostic of the generalized Eurysiphonata (Flower, 1941). This group, believed to spring from the Plectronoceratidae, is characterized by a thickened connecting ring in which various types of differentiation occur. It was regarded as beginning with the development of the Ellesmeroceratidae, straight or curved conchs with thick rings, and no accessory internal structures. From this group were derived the straight Baltoceratidae and the coiled Tarphyceratidae. The Endoceroidea developed first by the addition of endocones. Later prolongation of the necks produced holochoanitic structure, but the connecting rings are retained at least in the more primitive holochoanitic genera, and still show eurysiphonate characteristics. The rings of all of these groups exhibit two different types of patterns. Where the septal neck is short there is a dense thin inner (siphonal) zone and a lighter (cameral) inner zone. Where the necks are well developed and enclose the connecting ring for a considerable distance, the tip of the ring is differentiated into a mass of dense material, not unlike the inner zone, which was termed the eyelet. Assuming the deposits of *Bathmoceras* were developed from the eyelet, which grew forward over the inner (siphonal) side of the remainder of the connecting ring, it was possible to see in that genus the forerunner of *Polydesmia*, and the origin of the Actinoceroidea in which the inflated eyelet was modified into an annulosiphonate deposit.

While *Cyrtocerina* shows eurysiphonate affinities, it cannot be placed in any of the groups previously noted as members of the Eurysiphonata. On the other hand, it shows some features in common with the Diphragmida, which are very poorly understood at the present time, but the available evidence suggests that they also show eurysiphonate features. Possibly the connection is to be found in the genus *Levisoceras*, now placed in the Diphragmidae by Ulrich and Foerste (1933, 1936), but based upon a species originally placed in *Cyrtocerina*.

Levisoceras Foerste was first proposed because it was believed that *Cyrtocerina mercurius* was holochoanitic, while the genotype of *Cyrtocerina* was regarded as ellipochoanitic. Later Ulrich and Foerste (1933, p. 289), came to the conclusion that instead of being holochoanitic, the septal necks were actually very short, and that the connecting rings were peculiar in structure. Their statements are quoted below:

"However, two occurrences among the Diphragmida suggest that their structure may not have been holochoanoidal but ellipochoanoidal, the latter term having been introduced by Hyatt for siphuncles in which the septal necks are short and must be supplemented by connecting rings in order to produce a continuous siphuncle. For instance, several specimens from the central mineral region of Texas, apparently referable to *Levisoceras*, not only show the transverse tabulae within the siphuncle, but also segments of the siphuncle which are composed of short septal necks and intermediate connecting rings. Both surfaces of the septal necks are sharply defined from the adjacent matrix but those of the connecting rings apparently diffuse rapidly into the latter so that no sharp line exists between the rings and the matrix. Moreover, the substance of the connecting rings is slightly lighter in color than that of the septal necks."

The same forms were those which showed vestigial necks, as shown by the following statement of Ulrich and Foerste from the same paper: "In the Texan Diphragmida here described the septa curve downward only slightly on approaching contact with the siphuncle, this downward curvature being too slight to merit the name *neck*. They certainly are not orthochoanitic and the term aneuchoanitic (without neck) is here proposed for structures of this type."

Cyrtocerina agrees strikingly with *Levisoceras* in form. The genera have been separated on the basis of supposed internal differences. From the above quotations it can be seen that the genera agree in the aneuchoanitic necks, and the description of the connecting rings of *Levisoceras* might be equally well applied to those of *Cyrtocerina*. The only remaining difference is that *Levisoceras* is reported as possessing diaphragms which cross the siphuncle.

Cyrtocerina is unique among its contemporaries in the wall of the siphuncle. Its relationship can be best explained as a derivative of *Levisoceras* which has lost the diaphragms. At the present time, it is not possible to point out any other structural difference between the two genera. It is interesting to note in this connection that one section of *Cyrtocerina* which fails to attain the center of the siphuncle, shows apparent diaphragms because the processes of the connecting rings continue unbroken across the siphuncle. This suggests that some, though evidently not all, of the structures which have been described as diaphragms may be derived from connecting rings. This is particularly applicable to the exceedingly vague structures which Kobayashi (1933) has called pseudodiaphragms, in *Multicameroceras* and *Sinoeremoceras*.

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On Growth and Form

This voluminous book is an enlarged and revised edition of the book of the same title published twenty-five years ago. The problems of growth and form are discussed purely from the standpoint of mathematics and physics. In the words of the author his "sole purpose is to correlate with mathematical statement and physical law certain of the simpler outward phenomena of organic growth and structure or form, while all the while regarding the fabric of the organism as a material and physical configuration." The following paragraph contains samples of topics discussed and conclusions reached.

The total resultant force which the bird employs for its support varies empirically as the square of the air speed. Man is ruled by gravitation, whereas the surface of a pool is a matter of life and death to a water beetle. In the world where the bacillus lives gravitation is forgotten, whereas the viscosity of the liquid, molecular shocks of the Brownian movement and electrical charges of the ionized medium are all of great importance. The form of an organism is determined by its rate of growth in various directions and is an "event in space-time." The cell is a sphere of action of localised forces, of which surface tension is the most important in giving the cell its shape and individuality. The actual conformation of the cell usually is the complex resultant of surface tension, acting together with gravity, mechanical pressure, osmosis and other physical forces. The unique beauty of a soap bubble depends upon the absence of such forces from the field, the resulting form is in such a case so simple that we come to regard it as almost a mathematical abstraction. The various morphological characteristics of the tiny polyp have their parellels in the surface tension phenomena of the splash. The figure produced by using a hanging drop, which while it sinks remains suspended to the surface is analagous to that of a medusa or jellyfish, with its umbrella and manubrium. Flagella, cilia, chitinous hairs, etc., tend to occur where the surface tension would be least, were the surface fluid. Cell membrane and cell wall formation is the result of adsorption. In tissues or cell aggregates surface tension manifests itself in the minimum area which the circumstances of the case permit. Thus in a mass of soap bubbles enclosed in a narrow vessel with flat sides of glass, in a plane section of vegetable parenchyma, and on the surface of a honeycomb the cell walls meet by threes, at angles of 120°, forming hexagonal cells. This arrangement mathematically and physically, provides minimal surface. The efficient architecture of the bee cell is due to mechanical forces rather than to any planned economy on the part of the bee. The Nautilus, snail shell and Globigerna grow as equiangular spirals, rather than as the spiral of Archimedes. Shell forms which are mathematically identical are found in all geological periods, regardless of climate and on shores and in ocean depths. The quadriped skeleton has two balanced cantilevers, one supported on the fore-legs and the other on the hand. The skeletal construction of the bird is more complex, part of the time the whole weight is borne by the legs, and part of the time by the wings. Coordinate geometry may be of considerable value in illustrating differences between related forms.

The various subjects are treated along strictly physical and mathematical lines. Thus heredity and various physiological phenomena are not considered. Geometric and physical principles are discussed at length. Growth is considered in relation to magnitude, "as a phenomenon at the end of a morphological rather than at the beginning of a physical inquiry." While not offering solutions to any major biological problems, this book is a prolific source of unique and interesting material. The reader will likely learn more geometry and physics than biology.—*D. C. Rife.*

Growth and Form, by D'Arcy W. Thompson. xvii+1116 pp., 554 illus. MacMillan Co., New York, 1942. $12.50.

PHOTOPERIODIC AFTEREFFECTS IN IPOMOEA[1]

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Photoperiodic aftereffects[2] were first observed by Garner and Allard (8) in 1923, and have been studied since then in about two dozen species of plants. Due largely to the extensive studies of Borthwick and Parker (2, 3, 4, 17, 18), we now know more about photoperiodic aftereffects in Biloxi Soy Beans than in any other plant. Photoperiodic aftereffects in soy beans have also been studied by Garner and Allard (8), Eghiz (7), Murneek (15), and others. Considerable work on aftereffect in millet has been done by various Russian botanists (5, 6, 14, 23). Photoperiodic aftereffects in chrysanthemum have been studied by Poesch (19), Post (20, 21), and Link (13), in *Xanthium* by Hamner and Bonner (10) and Neidle (16), in dill by Hamner and Naylor (12), and in Klondike Cosmos by Biddulph (1). Other species which have been studied less thoroughly include teosinte, oats, barley, common cosmos, radish, poinsettia, rice, cotton, *Rudbeckia* and spinach. These studies have dealt primarily with reproductive aftereffects, but aftereffects involving tuber formation have been reported in *Solanum* by Razumov (24) and Pushkarev (22) and in *Helianthus tuberosus* by Hamner and Long (11).

In view of the fact that none of these plants has been a vine and that none has belonged to the *Convolvulaceae* the writer considered it worth while to investigate possible photoperiodic aftereffects in *Ipomoea*. The species employed were the Japanese morning glory (*I. hederacea* Jacq.) and the common morning glory (*I. purpurea* Roth.). Both of these species were classified by Garner and Allard (8) as short day plants, although Roberts and Struckmeyer (25) found that the latter species would also bloom under long photoperiods if the temperature was relatively low.

EXPERIMENTAL METHODS

A transfer technique similar to that employed in previous investigations on photoperiodic aftereffects was used. Plants of both species were subjected to from 1 to as many as 20 induction photoperiods of 9 hours each, transfers to long photoperiods being made daily. In the various experiments plants were kept under long photoperiods for different lengths of time before being subjected to the induction treatments, thus securing plants of different ages at the time the treatments were begun. Care was exercised that plants would be subjected to short photoperiods only during the allotted induction periods. Control plants were kept under short photoperiods from the beginning of the treatments to the end of the experiments. Other control plants were retained under long photoperiods throughout the experiments.

The experiments were conducted at Columbus, Ohio, between April 22 and September 3, 1939. The photoperiods designated as long were between 15 and 16¼

[1]Papers from the Department of Botany, The Ohio State University, No. 438.

[2]Although the terms *photoperiodic induction* and *photoperiodic aftereffect* are often used synonymously the writer believes that they logically refer to distinct phenomena. As used here the term *photoperiodic induction* is restricted to the initiation of sexual reproduction in plants under the influence of the photoperiod. The term *photoperiodic aftereffect* is applied to the continuation of reproductive development after photoperiods favoring its initiation have been replaced with photoperiods unfavorable or less favorable for induction. The term may also be applied to the continuation of vegetative development characteristic under certain photoperiods after these have been replaced by others under which such development would not initially occur. A detailed discussion of this terminology is given elsewhere (9).

hours in length. These were obtained by using the natural photoperiods, either alone or supplemented with light from Mazda bulbs; these providing a minimum of 3 foot candles of light, although most of the plants received at least 20 foot candles of light. The photoperiods designated as short were 9 hours in length, and were obtained by means of light-proof, ventilated chambers and cabinets. The temperature differences between the inside and outside of these were not great enough to have any significant effect on the development of the plants. The minimum temperature to which any of the plants was exposed was 56° F., and for short periods only. The mean temperatures ranged between 70° F. and 80° F.

The plants were maintained in five-inch porous clay pots according to good greenhouse practice, and care was taken to keep such factors as soil, moisture and light intensity as uniform as possible.

TABLE I

DATA ON THE ORGANIZATION OF THE EXPERIMENTS

SPECIES	EXPT. NO.	DATE PLANTED	NUMBER OF DAYS FROM PLANTING SEEDS TO THE:			PLANTS PER TREATMENT
			Beginning of Treatments	Time of the Last Transfer	End of the Experiment	
I. hederacea (yellow-green)	I	April 21	40	60	96	2
" "	II	June 13	4	21	62	3
I. hederacea (dark green)	III	June 29	5	18	66	4
" "	IVa	June 29	28	38	66	4
" "	IVb	June 29	28	41	66	3
I. purpurea	I	April 21	40	60	96	3
" "	II	June 13	4	22	66	4
" "	III	June 29	5	22	66	3
" "	IV	June 29	28	45	66	3

Eight different experiments were conducted, four on each species. In the first two experiments on *I. hederacea* a strain with pale yellow-green foliage was used, while in the last two a strain with dark green pigmentation, similar to that of *I. purpurea*, was employed.

In Experiment IV on *I. hederacea* the plants were divided into two series, *a* and *b*. The plants in Series *a* were treated in the usual way, but the plants in Series *b* had only one leaf each exposed to nine hour photoperiods. This was accomplished by means of light-proof black cloth bags placed in position and removed daily.

Daily records were made of the development of the plants, including a complete record of anthesis, and at the close of each experiment the height of each plant was measured and the number of fruits on each was counted. All plants which had not bloomed were carefully examined for flower buds with a low power binocular

microscope. Specific details about the organization of the experiments are given in Table I.

RESULTS AND DISCUSSION

Detailed data on each of the experiments are too extensive to present here but are available elsewhere (9). It will suffice here to describe and discuss the more important results, considering in turn the aftereffects related to flower bud formation, anthesis, and fruit formation.

Flower buds developed on at least some of the plants in all the treatment groups in the experiments on *I. hederacea* (Table II), and in the first three experiments flower buds were also present on the control plants, which were retained under photoperiods 15 hours or more in length throughout the experiments. However, the influence of the short day treatments was clearly evident, as the buds on

TABLE II

MINIMUM NUMBERS OF SHORT PHOTOPERIODS WHICH INDUCED VARIOUS AFTEREFFECTS

EXPERIMENT	MINIMUM NUMBERS OF SHORT PHOTOPERIODS WHICH INDUCED					
	Flower Buds	Terminal Flower Buds	Anthesis	First Anthesis	Last Initial Anthesis	Fruit Formation
Ipomoea hederacea I	0	2	0	12	0	0
" " II	0	2	2	11	2	2
" " III	0	5	5	13	5	5
" " IVa	1	7	3	7	3	6
" " IVb	1	11	4	9	4	13
Ipomoea purpurea I	2	8	3	4	3	4
" " II	7	13	7	10, 11, 14, 16, 17	12	13
" " III	11	12	11	7	11, 12	12
" " IV	2	17	8	14, 15	9	17

the control plants appeared much later than on the treated plants, and in no case before the plants were 46 days old. None of the *I. purpurea* plants exposed to less than 2 short photoperiods formed flower buds, and in Experiments II and III on this species flower buds appeared only on plants exposed to 7 or more and 11 or more short photoperiods respectively. Since treatments were begun in these experiments 4 and 5 days respectively after planting, and were not begun until 40 and 28 days after planting in the other two experiments, it appears that induction treatments may be more effective in inducing flower bud formation when applied to older plants. The formation of flower buds on the control plants of *I. hederacea* indicates that this is less strictly a short day species than *I. purpurea*.

More short photoperiods were necessary for the induction of terminal flower buds than lateral flower buds (Table II). The yellow-green plants of *I. hederacea* were most sensitive in this respect, terminal flower buds developing on some of

the plants exposed to 2 to 4 short photoperiods, and on all the plants exposed to 5 or more short photoperiods. Terminal flower bud formation was much less extensive in the dark green plants of this species, being present only in scattered plants exposed to 5 or more short photoperiods. A terminal flower bud formed on only one of the plants subjected to localized induction photoperiods, it having been exposed to 11 short photoperiods.

In *I. purpurea* terminal flower buds were also rare, and except in the first experiment occurred only on scattered plants exposed to 12 or more short photoperiods. In the first experiment terminal flower buds formed on one plant each in the groups exposed to 8, 9, 10, and 14 short photoperiods and on all plants exposed to 15 or more short photoperiods. The greater abundance of terminal flower buds on these plants was probably due in part to the greater age of the plants at the time the treatments were begun, and in part to the fact that this experiment was continued a month longer than the other experiments on *I. purpurea*. Terminal flower buds formed on all plants of both species which were retained under short photoperiods from the beginning of the treatments to the ends of the experiments. Most of the terminal flower buds developed into flowers, but a few on the plants subjected to the lesser number of short photoperiods failed to develop further.

A very striking result of the formation of terminal flower buds was a cessation of growth of the main axis and the consequent dwarfing of the plants (Fig. 1). In some of the plants exposed to fewer numbers of short photoperiods branches continued to grow and one exhibited apical dominance. The resulting plant as a whole had the usual viny form, but in most of the plants terminal flower buds soon formed on the branches, resulting in a bushy plant entirely unlike the usual morning glory plant. It is possible that non-viny *Convolvulaceae*, such as *Convolvulus tricolor*, are bushy because their terminal flower buds develop under longer photoperiods than in other members of the family.

The average height of the dwarfed plants was 30 cm. for the plants treated beginning 4 or 5 days after planting and 118 cm. for those treated when older. The yellow-green plants of *I. hederacea* averaged the shortest, followed in order by the dark green plants of this species and the *I. purpurea* plants. In all but one experiment (*I. purpurea*, Expt. III) the plants retained under short photoperiods were shorter on the average than the plants returned to long photoperiods after induction, apparently because of the continued influence of the short photoperiods. No explanation for the exception is evident. However, formation of terminal flower buds did not necessarily occur earlier with an increase in the number of induction photoperiods, many plants exposed to the larger numbers of short photoperiods having main stems averaging about the same in height as those on which terminal flower buds developed after exposure to as few as 2 short photoperiods. The shortest main stems were those of two plants of *I. hederacea* in Experiment I which had been exposed to 15 and 16 short days and were only 8 cm. tall.

In general, extensive branching accompanied the formation of terminal flower buds, probably as a result of the loss of apical dominance, and branching was rare in plants with terminal vegetative buds. For example, in Experiment I on *I. hederacea* 78 per cent of the plants had terminal flower buds and 71 per cent had branches, while in Experiment III on this species only 8 per cent had terminal flower buds and none had branches. When plants with terminal flower buds failed to branch, as was evident particularly in Experiment II on *I. hederacea*, in which 78 per cent of the plants had terminal flower buds but only eight per cent had branches, it was evidently because all the axillary buds had developed into flower buds so that no further stem elongation was possible.

In Experiment I on *I. hederacea* the control plants kept under long photoperiods began blooming 85 days after planting. None of the control plants in the other

experiments bloomed, although some of the *I. hederacea* controls which had flower buds might have bloomed had the experiments been continued longer. In these experiments the minimum number of short photoperiods necessary to induce anthesis ranged from 2 to 5, and in *I. purpurea* from 3 to 11 (Table II). Using this as a criterion *I. hederacea* may be considered as more sensitive to photoperiodic induction than *I. purpurea*, and the yellow-green strain of the former species as more sensitive than the dark green strain.

Aftereffects were much more pronounced in the yellow-green plants of *I. hederacea* than in the dark green plants of either species insofar as abundance of bloom is concerned, and flowers were more abundant on the dark green plants of *I. hederacea* than on the *I. purpurea* plants. There was a general tendency for the

Fig. 1. Representative plants of *Ipomoea hederacea*, Experiment II, showing the dwarfing which resulted from the conversion of the terminal bud to the determinate reproductive condition. The figures give the number of short photoperiods to which the plants were exposed. The plant labeled "C" was retained under long photoperiods throughout the experiment. Photographed July 31, 1939.

plants exposed to greater numbers of short photoperiods to bloom more abundantly than those exposed to smaller numbers, but there was no regular increase in abundance of bloom with an increase in the number of induction photoperiods. All plants retained under short photoperiods bloomed much more abundantly than those returned to long photoperiods. There was no distinct correlation between either the abundance of bloom or the minimum number of short photoperiods necessary to induce anthesis and the age of the plants at the time the treatments were begun.

In *I. hederacea* anthesis first occurred in plants exposed to a fairly large number of short photoperiods, and the last plants to begin blooming were ones exposed

to only a few short photoperiods, but this was not true of *I. purpurea* (Table II). Anthesis first began in the plants retained under short photoperiods from the beginning of the treatments at about the same time as in the plants returned to long photoperiods (Table III). Both the time of initial anthesis and the beginning of the period of maximum anthesis correlated with the number of days from the beginning of the treatments rather than with the number of days from planting (Table III). The time from the beginning of the treatments to the first anthesis varied from 21 to 30 days and the time to the beginning of maximum anthesis varied from 25 to 30 days. That the treatments were somewhat more effective on plants which were older at the beginning of the treatments is indicated by the fact that the average time from the beginning of the treatments to initial anthesis was 24 days for the older plants and 29 days for the younger plants. The average time to the beginning of maximum anthesis was 28 and 30 days respectively. There was little difference between the two species or between the yellow-green and dark green plants in the time required for initial and maximum anthesis to begin.

The number of short photoperiods necessary for the induction of fruit formation was about the same as that for the initiation of terminal flower buds (Table II), and except in the first three experiments on *I. hederacea* was greater than the number required for inducing anthesis. Fewer numbers of short photoperiods were necessary in both strains of *I. hederacea* than in *I. purpurea*, except in the plants of which single leaves were exposed to localized short photoperiods. The percentage of the test plants bearing fruits was markedly higher in *I. hederacea* than in the comparable experiments on *I. purpurea*, except in Experiment I on each species, where the longer duration of the experiments may have made some equalization possible, and in the plants given localized short photoperiods, only 5 per cent of which formed fruits. In Experiment I, fruits developed on 73 per cent of the *I. hederacea* plants and on 61 per cent of the *I. purpurea* plants. In Experiments 2, 3, and 4 the percentages were 61 and 13, 24, and 7, and 40 and 2 for *I. hederacea* and *I. purpurea* respectively. Fruits developed on 77 per cent of the plants retained under short photoperiods. The percentage of flowers developing into fruits was extremely variable from treatment to treatment and there was no correlation with the number of short photoperiods or the species, but it was higher in the plants retained under short photoperiods than those returned to long photoperiods.

Photoperiodic aftereffects were evident in the plants of *I. hederacea* which had only one leaf each exposed to short photoperiods (Exp. IV b), but these were much less extensive than in comparable plants exposed in their entirety to short photoperiods (Exp. IV a). Flower buds formed on a plant exposed to only one localized short photoperiod, anthesis occurred on plants exposed to 4 or more localized short photoperiods except in the groups exposed to 5 and 10 short photoperiods, and fruits formed on one plant exposed to 13 localized short photoperiods. A terminal flower bud developed on one plant exposed to 11 localized short photoperiods when it was 101 cm. high.

The various tabulations fail to indicate adequately the rather marked differences in development among plants receiving identical treatments. These differences of reaction to the photoperiod were in many cases too marked to be due to other slight differences in environment and it appears that individual hereditary differences in reaction to the photoperiod are greater within ordinary unselected species than is generally recognized.

The more pronounced photoperiodic aftereffects of the yellow-green strain of *I. hederacea* than of the dark green strain may have been due either to genetic linkage of the factors affecting sensitivity to the photoperiod and the factors affecting pigment formation, or to a more or less direct physiological connection between pigmentation and sensitivity to the photoperiod. The latter appears

possible since Murneek (15) found that in several short day plants the carotene and xanthophyll content was higher in plants growing under short photoperiods than those growing under long photoperiods.

A quantitative and cumulative relationship between exposure to short photoperiods and photoperiodic aftereffects was indicated by the following results: a general increase in photoperiodic aftereffects with an increase in the number of short photoperiods to which the plants were exposed; more extensive reproductive development in plants retained under short photoperiods than in those returned to long photoperiods; and the lesser aftereffects in *I. hederacea* plants exposed to localized short photoperiods than in comparable plants exposed in their entirety to short photoperiods. These results are in accord with the florigen theory.

TABLE III

LENGTHS OF TIME FROM PLANTING AND BEGINNING OF TREATMENTS TO THE INITIATION OF ANTHESIS

EXPERIMENT	NUMBER OF DAYS FROM PLANTING TO:				NUMBER OF DAYS FROM BEGINNING OF TREATMENTS TO:	
	Beginning of Treatments	First Anthesis of		Period of Maximum Anthesis	First Anthesis	Beginning of Maximum Anthesis
		Test Plants	Short Day Plants			
Ipomoea hederacea I	40	64	..	70–80	24	30
" " II	4	31	..	35–41	27	31
" " III	5	35	36	36–43	30	31
" " IVa	28	54	52	56–66	26	28
" " IVb	28	56	52	56–66	28	28
Ipomoea purpurea I	40	61	..	65–80	21	25
" " II	4	34	35	34–40 58–62	30	30
" " III	5	33	36	34–37	28	29
" " IV	28	51	51	55–62	23	28

SUMMARY

Plants of *Ipomoea hederacea* and *I. purpurea* exhibited photoperiodic aftereffects in various degrees when transferred to long photoperiods after having been exposed to various numbers of 9 hour photoperiods. In general, more short photoperiods were necessary to induce anthesis than flower bud formation, and still more to induce fruit formation. The photoperiodic aftereffects were generally more pronounced with an increase in the number of short photoperiods to which the plants were exposed and with an increase in the age of the plants at the time the treatments were begun, but reproductive development was not as extensive in the transfer plants as in those retained under short photoperiods from the beginning of the treatments to the end of the experiments.

A pale yellow-green strain of *I. hederacea* exhibited more marked photoperiodic aftereffects than plants of the dark green strain of this species, and the aftereffects in *I. purpurea* were less marked than in either strain of *I. hederacea.*

Except in one experiment, flower buds developed on plants of *I. hederacea* retained under long photoperiods, indicating that this species is not strictly a short day plant, although the added influence of the short day treatments was clearly evident. In *I. purpurea* flower buds developed only on plants exposed to 2 or more short photoperiods.

Terminal flower bud formation occurred only after exposure to minima of from 2 to 7 short photoperiods in *I. hederacea* and 8 to 17 short photoperiods in *I. purpurea*, and was much more frequent in the former. This resulted in the formation of dwarf plants, many of which were bushy and some of which had main stems as short as 8 cm. The plants on which experiments were begun when they were very young were shorter than those on which treatments were begun later. Branching was in general more extensive on the plants with terminal flower buds, but some of these did not branch because all lateral buds had developed into flower buds.

The minimum number of short photoperiods which induced anthesis in *I. purpurea* was 3 and the minimum in *I. hederacea* was 2, except that in one experiment on the yellow-green strain of the latter species even the plants retained under long photoperiods bloomed. Anthesis began in from 21 to 30 days after the beginning of the treatments. Initial anthesis occurred about the same time in some of the transfer plants as in those retained under short photoperiods. The number of short photoperiods necessary for induction of fruit formation was about the same as that for the initiation of terminal flower buds.

Plants of the dark green strain of *I. hederacea* exhibited photoperiodic aftereffects after the application of localized short photoperiods to one leaf, but these aftereffects were much less marked than those in comparable plants exposed in their entirety to short photoperiods.

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Human Heredity in Picture Form

In this book the author has presented the thesis that many common normal traits run in families and make fascinating material for studies in human heredity. Photographs and descriptions are offered of about 200 such traits. For those who have gotten the impression that only the abnormalities stressed by many authors are genetic, the book brings a refreshing viewpoint on normal and benign variations. For the serious student of genetics, however, the book is disappointing. References to literature are poorly chosen. Older literature is often cited and modern interpretations ignored. Many of the subjects discussed have no citations at all, although good papers exist.

The phylogenetic relations of genes are badly mishandled. This reviewer has on numerous occasions pointed out the lack of understanding of matters of genotype equilibrium on the part of writers on human heredity. The author of this book says, for example, (p. 109) "Since about 65 per cent of individuals can roll the tongue, this trait may be a dominant one."

Psychologists will find much to disagree with in the book, particularly in the chapter on temperaments and special abilities. Even the most genetically-minded psychologist (or biologist) will find it difficult to accept a genetic basis for such a trait as good taste in dress.

A chapter is included on sex and sex-determination, and a glossary of 91 terms and an index complete the book.—*L. H. Snyder.*

Family Treasurers, by David D. Whitney. 299 pp., 234 fig. Lancaster, Penna., the Jaques Cattell Press, 1942. $3.50.

THIRD ANNOTATED LIST OF PHYMATA PREY RECORDS (PHYMATIDAE, HEMIPTERA)

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During the three years 1938, 1939 and 1940 I made a study of the prey utilized by our common ambush bug, *Phymata pennsylvanica americana* Melin in the vicinity of Urbana, Illinois. The method employed was direct search for the predator as it occupied flowers, mostly wild, growing along roads, ditches and pastures. When Phymatas were discovered possessing prey, the latter was taken from their grasp and placed in a vial with notes identifying the ambush plant and stating whether the preying bug was single, and if so its sex, or coupled or mating, or in some other combination to be described below. Throughout the project I included prey specimens found dead under circumstances that left no reasonable doubt that they had been killed and discarded by *Phymata*. These, however, represent less than 10 per cent of the total. Excepting a few from fifth instar nymphs, all the prey recorded during the study pertained to adult bugs.

The present report, which is intended as the last of this series, embraces the records for 1940. The annotated lists for the preceding two years have already been published (Balduf, 1939, 1940).

TABLE I

INSECT PREY OF *Phymata*, 1940

SYSTEMATIC POSITION OF PREY TAKEN			SPECIMENS CAPTURED	INCLUSIVE DATES
Genus	Species	Family		
	COLEOPTERA			
Diabrotica	*12-punctata* (Fabr.)	Chrysomelidae	10	VII-17: X-5
Diabrotica	*longicornis* Say	Chrysomelidae	1	IX-6
	HYMENOPTERA			
Amblyteles	*brevicinctor* (Say)	Ichneumonidae	1	VII-17
Porizon	sp.	Ichneumonidae	1	VII-19
Microbracon	*tenuiceps* Mues	Braconidae	1	VII-19
Bassus	*annulipes* (Cr.)	Braconidae	2	IX-2
Urisigalphus	*femoratus* Cwfd	Braconidae	2	IX-7: IX-9
Apanteles	*forbesi* Vier	Braconidae	1	IX-19
		Pteromalidae	1	IX-19
Apis	*mellifica* Linn	Apidae	8	IX-4: X-5
Bombus	*impatiens* Cress	Bombidae	1	IX-11
Agapostemon	*radiatus* (Say)	Andrenidae	2	VIII-9: IX-16
Calliopsis	*andreniformis* Sm	Andrenidae	6	VII-25: X-21
Andrena	*nubecula* Sm	Andrenidae	1	IX-4
Halictus	*provancheri* D. T	Halictidae	8	VII-17: IX-28
Halictus	*stultus* Cress	Halictidae	4	VII-19: XI-2
Halictus	*coriaceus* Sm	Halictidae	1	VII-25
Halictus	*pruinosus* Robt	Halictidae	1	VII-25
Halictus	*ligatus* Say	Halictidae	1	VII-25
Halictus	*albipennis* Robt	Halictidae	1	VIII-9

[1]Contribution No. 223 from the Entomological Laboratories of the University of Illinois. I am again indebted to Mr. C. F. W. Muesebeck and several of his scientific staff in the United States National Museum for determining the prey insects reported here.

TABLE I—(Continued)

Systematic Position of Prey Taken			Specimens Captured	Inclusive Dates
Genus	Species	Family		
	Hymenoptera (Continued)			
Halictus	*versatus* Robt.	Halictidae	17	IX-6: X-28
Halictus	spp.	Halictidae	8	IX-19: X-28
Augochlorella	*striata* (Prov.)	Halictidae	1	IX-28
Paralictus	*platyparius* Robt.	Halictidae	1	X-5
Coelioxys	*octodentata* Say	Megachilidae	1	VII-26
Hylaeus	*stevensi* Cwfd.	Hylaeidae	1	IX-14
Epeolus	*bifasciatus* Cress.	Nomadidae	1	IX-3
Philanthus	*ventilabris* Fabr.	Sphecidae	1	VII-17
Sphex	*placidus* (Sm.)	Sphecidae	5	VII-20: VII-25
Larropsis	*distincta* (Sm.)	Sphecidae	1	IX-7
Crabro	sp.	Sphecidae	1	IX-26
Psen	*cressoni* (Pack.)	Sphecidae	1	IX-28
Cerceris	*finitima* Cress.	Sphecidae	1	VII-20
Cerceris	*clypeata* Cress.	Sphecidae	1	VII-25
Cerceris	sp.	Sphecidae	1	IX-14
Neoformica	sp.	Formicidae	6	VII-17: VII-25
Formica	*pallidefulva nitidiventris* Em.	Formicidae	1	IX-11
Formica	*pallidefulva schaufussi incerta* Em.	Formicidae	1	IX-26
	Lepidoptera			
Ascia	*rapae* (L.)	Pieridae	2	VII-25: IX-28
Colias	*philodice philodice* Godt.	Pieridae	2	IX-11: IX-13
Colias	*eurytheme* Bdv.	Pieridae	8	IX-28: X-28
Everes	*comyntas comyntas* Godt.	Lycaenidae	3	VII-25: IX-12
Polites	*themistocles* (Latr.)	Hesperiidae	1	IX-12
Pyrgus	*communis communis* (Gr.)	Hesperiidae	2	IX-12: IX-21
Schinia	*acigera* Gn.	Phalaenidae	1	IX-19
Rhodophora	*gaurae* (A. & S.)	Phalaenidae	1	VIII-8
Tarachidia	*candefacta* Hbn.?	Phalaenidae	1	IX-7
Prodenia	*ornithogalli* Gn.	Phalaenidae	1	X-5
Feltia	*subgothica* (Haw.)	Phalaenidae	24	IX-7: X-5
Caenurgina	*erechtea* (Cram.)	Phalaenidae	2	IX-12
Crambus	*albellus* Clem?	Crambidae	1	IX-16
Scythris	sp.	Schthridae	1	XI-2
	Diptera			
Eugnoriste	*brevirostris* Coq.	Mycetophilidae	1	VII-17
Sciara	sp.	Mycetophilidae	5	IX-21: IX-28
Aedes	*vexans* (Mg.)	Culicidae	3	IX-16: IX-26
Culex	*tarsalis* Coq.	Culicidae	1	IX-26
Empis	*clausa* Coq.	Empididae	8	IX-14: IX-19
Occemyia	sp.	Conopidae	4	IX-19: X-28
Sparnipolius	*fulvus* (Wied.)	Bombyliidae	15	IX-11: IX-28
Madiza	sp.	Chloropidae	1	IX-6
Hippelates	sp.	Chloropidae	1	IX-26
Hylemya	sp.	Anthomyidae	12	VII-20: IX-28
Sarcophaga	*tenuiventris* V. d. W.	Sarcophagidae	1	IX-11
Sarcophaga	*salva* Aldr.	Sarcophagidae	1	IX-12
Sarcophaga	*sinuata* Mg.	Sarcophagidae	1	IX-28
Sarcophaga	*lherminieri* R. D.	Sarcophagidae	2	IX-19: IX-28
Sarcophaga	sp.	Sarcophagidae	1	IX-19
Senotainia	sp.	Sarcophagidae	1	IX-28
Pollenia	*rudis* (Mg.)	Calliphoridae	1	IX-4

TABLE I—(Continued)

Systematic Position of Prey Taken			Specimens Captured	Inclusive Dates
Genus	Species	Family		
	Diptera—(Continued)			
Cochliomyia	*macellaria* (F.)	Calliphoridae	2	IX-7: IX-28
Lucilia	*illustris* (Mg.)	Calliphoridae	1	IX-19
Stomoxys	*calcitrans* (L.)	Muscidae	1	IX-16
	spp.	Tachinidae	4	IX-2
Chaetogaedia	*monticola* Big.	Tachinidae	1	IX-3
Voria	*ruralis* (Fall.)	Tachinidae	1	IX-3
Paradidyma	sp.	Tachinidae	1	IX-12
Winthemia	sp.	Tachinidae	3	IX-19
Archytas	sp.	Tachinidae	1	IX-28
Hyalomya	*aldrichi* Tns.	Tachinidae	6	IX-30: X-28
Cistogaster	*immaculata* Macq.	Tachinidae	1	IX-30
Cistogaster	*occidua* (Wlk.)	Tachinidae	2	X-23
Sphaerophoria	*cylindrica* (Say)	Syrphidae	3	VII-25: IX-28
Eristalis	*arbustorum* (L.)	Syrphidae	5	VII-25: IX-28
Eristalis	*tenax* (L.)	Syrphidae	7	VIII-8: X-23
Allograpta	*obliqua* (Say)	Syrphidae	1	VIII-8
Syritta	*pipiens* (L.)	Syrphidae	8	IX-16: X-23
Syrphus	*wiedemanni* Johns.	Syrphidae	2	IX-3: IX-12
Syrphus	sp.	Syrphidae	1	X-23
Mesogramma	geminata (Say)	Syrphidae	1	X-23
	Neuroptera			
Chrysopa	*plorabunda* Fitch	Chrysopidae	1	IX-12
	Hemiptera			
Corizus	*lateralis* Say	Corizidae	1	VII-20
Lygus	*pratensis* (L.)	Miridae	4	VII-20: X-17
Lygus	*pratensis oblineatus* (Say)	Miridae	1	IX-2
Lygus	*pratensis strigulatus* (Wlk.)	Miridae	1	IX-6
Plagiognathus	*politus* Uhl.	Miridae	5	IX-3: IX-30
Adelphocoris	*rapidus* (Say)	Miridae	9	VII-27: X-21
Peribalus	*limbolarius* Stal.	Pentatomidae	1	IX-2

SUMMARY

The list for 1940 embraces 97 species and a few varieties represented by a total of 228 individuals, all of which were insects in the adult state excepting an advanced nymph of the common mirid bug, *Adelphocoris rapidus*. These species belong to six orders—Coleoptera, Hymenoptera, Lepidoptera, Diptera, Neuroptera and Hemiptera. A large part of the total is bees, moths and flies. Members of the holometabolous orders again constitute by far most of the prey, or 92.36 per cent as contrasted with 7.64 per cent Heterometabola. This predominance of Holometabola merely signifies that chrysomelid beetles, moths, butterflies, bees, wasps, ants and many kinds of dipterous flies take as a considerable part of their food the pollen, petals or nectar of flowers and by that practice attract their predatory enemy *Phymata* to the same situations.

Moreover, as in 1938 and 1939, the prey value of the several species composing the list exhibits great plasticity. Were records of the present kind taken for years without end, they would obviously continue indefinitely to be characterized by such variation. The causes lie, in general, in the fluctuations in the climatic and biotic influences that surround the insect fauna everywhere. Some species appear

for the first time in this list, while others present in 1938 and 1939 are lacking from it, and those represented consistently in all the three years played changing roles in respect to their quantitative prey value.

FEEDING COMBINATIONS

Of the 228 instances of predation reported for this year, the sex of the preying phymatid was noted in 268. The several preying combinations and their relative frequency are summed up in Table II.

TABLE II

PREYING COMBINATIONS

PREY FED ON BY	NUMBER	PER CENT OF TOTAL	PREY FED ON BY	NUMBER	PER CENT OF TOTAL
Single males	61	22.75	Mating males	0	0.00
Single females	131	48.85	Mating females	5	1.85
Coupled males	6	2.28	Both sexes of mating pairs	1	0.36
Coupled females	51	19.04	Other combinations	6	2.28
Both sexes of coupled pairs	7	2.59	Grand totals	268	100.00%

It will be seen that 71.50 per cent of the 268 prey insects were found in possession of single male or female captors, i. e., Phymatas neither coupled nor *in copulo;* that 19.04 per cent was captured by females of coupled pairs as against only 2.28 by males of couples; that five females engaged in feeding while mating as compared with no males feeding alone in that relation. In one instance, the members of a mating pair fed simultaneously on a small mirid bug, *Plagiognathus politus.*

Counting all the above feeding bugs as individuals, i. e., disregarding the several paired combinations, I find males were concerned in only 81 instances whereas females totaled 199. In other words, 29 per cent of the feeding was done by males and 71 per cent by the females. The corresponding data for 1938 were 25.9 and 74.1, and for 1939, 17.9 and 82.1 per cents. These figures give a three-year average of 24.27 and 75.73 per cent, for male and female, respectively, showing that, on the whole, the females capture and feed approximately three times more frequently than the males. In general they also utilize larger insects than the males secure. In terms of actual quantity of food substance ingested, the females may be conservatively estimated to take four times more quantity of food than the males. More or less complete data taken during the three years show that the sex ratio annually averaged approximately 1 : 1. This normal intersexual disparity in rate of feeding is correlated with the much greater bulk of sexual products, expressed in terms of eggs, developed by the female. This correlation is indicated also by weights of almost 500 males and females collected on seven different dates between July 17 and September 28, the period representing the inception, and rise to the peak, of sexual productivity. On July 17, the average young male weighed 0.0210 gr. and the female 0.0340 gr., or 1.63 times the weight of the male, while on September 2, the respective weights had mounted to 0.0270 and 0.0540—the average female weighing twice the average male. This greater rate of acceleration in weight in the female runs parallel with the greater bulk of sexual products yielded by this sex. Spermatogenesis requires a smaller quantity of nutriment than oögenesis.

In addition to the majority feeding combinations noted above, the following unusual cases deserve brief description.

1. Two males and a female feeding together separately on a *Sphex placidus*.

2. Male and female feeding separately and simultaneously on an *Eristalis arbustorum*.

3. Female of a coupled pair feeding on an adult of *Adelphocoris rapidus* while the mate fed on a chloropid fly, *Madiza* sp.

4. Two males feeding on a screw worm fly, *Cochliomyia macellaria*, while only one of them held the captive.

5. A male holding a wasp, *Psen cressoni*, with one front leg and an anthomyid fly, *Hylemya* sp., with the other. Both captives were dead; had doubtlessly been captured and killed by this bug.

6. A female holding a dead bee, *Halictus versatus*, with one front leg and another bee of the same species with the other. The bug was feeding on the latter captive.

7. The female of a coupled pair had just captured a moth, *Feltia subgothica*—the latter fluttering vigorously as I came upon the scene. Within a minute, the bug drew the resisting moth in reach of her proboscis. In another minute the deadening injection had inactivated the moth. Sitting on his mate's back during this period, the male now moved forward to come in on the kill.

8. A female was found holding to the head and thorax of a tachinid fly and seemed to be feeding. Considering that *Phymata* has not been seen to date to seize dead insects and that the body of the fly was torn raggedly, I suspect some chewing predator—wasp or beetle—had eaten away the abdomen and a part of the thorax of the fly which *Phymata* had captured and killed.

9. A male *Phymata* held with one front leg to the extended siphon of an adult *Feltia subgothica* that had approached a flower of *Aster multiflorus* to feed. Having grasped the siphon near its apex, the bug was unable to draw the moth within reach of his stylets to inject the inactivating fluid. The moth fluttered violently, shaking the plant sharply, and threatened to jerk the bug from his perch. During the subsequent 10 minutes, the moth relaxed at intervals its efforts to escape, and in these lulls the bug renewed, without success, his efforts to make contact with his piercing organs. In the following 15 minutes the moth hung limp except for brief and feeble struggles, and in a few minutes more was dropped by the frustrated bug. Sixteen hours later *Feltia* was dead of exhaustion, while *Phymata* crawled about in perky fashion. At this time, the moth weighed 0.0354 gr., the bug 0.0167, or less than half his captive.

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A NEW GENUS (DELTORYNCHUS) AND TWO NEW SPECIES OF LEAFHOPPERS (HOMOPTERA CICADELLIDAE) FROM MEXICO

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A study of the Mexican leafhopper fauna has revealed many interesting species and records. The material which is herein described is one of the interesting new genera and species.

Genus **Deltorynchus** nov.

Related to *Mesamia* but with a more produced vertex which is flat on the disc with the apex slightly upturned. The pronotum slopes definitely to the vertex. In lateral view the margin is thick and the face is somewhat convexly rounding from the clypeus to upper edge of vertex. The venation is simple in type with the second anteapical cell decidedly longer than the first and narrowed at middle. Genotype *Deltorynchus quadrinotus* n. sp.

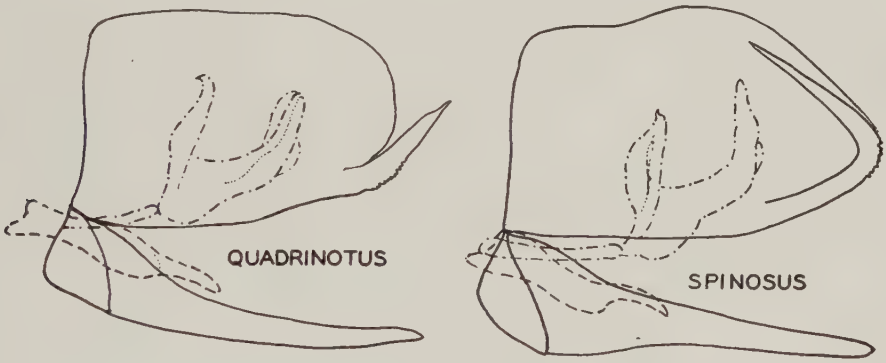

Fig. 1. Lateral view of male genitalia as labeled.

Deltorynchus quadrinotus n. sp.

A yellowish species marked with orange and white and with black spots on margin of vertex. Length 5 mm.

Vertex produced and bluntly angled, about one-fifth wider between eyes than median length. Head including eyes decidedly narrower than pronotum. Elytra long and narrow.

Color.—Vertex orange, margin more yellowish with four large black spots on margin about equidistant from each other and from the eyes. Pronotum yellow with a broad median transverse orange band. Scutellum orange on anterior half and yellow on posterior half. Elytra yellow subhyaline marked with brown except a large pale triangular spot on costa just before the middle and a smaller pale costal spot just before apical cross veins. Large white areolar spots are prominent on clavus and in base of apical cells. Face and beneath bright yellow unmarked.

Genitalia.—Male plate rather long, slightly indented on outer margin at about half its length then tapered to a blunt apex. Style rather broad at base, apical fourth narrow, apex curved outwardly. Aedeagus broadly U-shaped, rather thick at base with a long portion projecting dorsally. The apical half is narrowed abruptly curved dorsally at two-thirds its length with

the apex bluntly rounded. The pygofer bears a heavy black spine on the ventral apical margin which extends caudally and bears several tooth-like spines on the inner margin.

Holotype male and paratype males from Iguala, Gro., Mexico, September 11, 1939, and October 25, 1941, collected by C. C. Plummer, E. E. Good and the author. Paratype males are also at hand from Balsas, Gro., Mexico, August 15, 1930 (M. F. 1754) collected by J. Parra. One paratype male collected on the Cuernavaca Acupulca Road, August 24, 1936, by Ball and Stone is in the Ball collection. Holotypes and paratypes in author's collection.

Deltorynchus spinosus n. sp.

In general form, appearance and coloration resembling *quadrinotus* but with shorter, more bluntly angled vertex and with distinct male genitalia. Length male 5.5 mm.

Vertex rather broad and bluntly angled, one-third wider between eyes than median length.

Color.—Vertex yellow, tinged with orange, with four black spots on margin. The two at the apex are larger and proximal with a smaller spot halfway between apex and eye on either side. Pronotum yellow with a broad transverse median band which is about half as wide as length of pronotum. Pronotum yellow, basal angles brown. Elytra white with clavus, a transverse band just posterior to middle and another across apex of elytra brown. The transverse bands reach to the costa forming two large white costal spots one either side of the median cross band. Numerous white circular spots throughout the brownish coloration, especially larger and conspicuous on the clavus. Face pale yellow.

Genitalia.—Male plates triangular, concavely indented just beyond middle then tapered to a pointed apex. Aedeagus U-shaped with the posterior arm of the "U" longer than the basal portion. In lateral view the basal portion is broad with a dorsally directed process which arises at the basal dorsal angle and is short and rather broad. The basal portion is abruptly narrowed at about half its length, then curved to form a long tapered and apically pointed process. The dorsal caudal margin of the pygofer is roundedly sloping to the basal caudal angle from which a long black spine arises and curves dorsally around the caudal margin of pygofer and extends to the dorsal margin of the pygofer.

Holotype male collected at Cuautla, Mor., Mexico, August 27, 1937 (M. F. 6247) by Dr. Dampf, in author's collection.

STAINING INULIN CRYSTALS IN PLANT TISSUES[1]

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Inulin, a levulosan, is found widely distributed among numerous angiosperm families. This carbodyhrate occurs in solution in the cell sap of some species, in others it accumulates as an amorphous material, and in some plants inulin crystals are found deposited in living tissues. Inulin stains brown in iodine and will not reduce Fehling's solution. It may be precipitated as sphaero-crystals within the cells of some tissues when immersed in 70 per cent ethyl alcohol. The enzyme inulase in plant tissues hydrolyzes inulin to fructose. A microchemical test for inulin consists of treating freehand sections of plant tissues with a drop of 15 per cent thymol (15 grams of thymol dissolved in 85 cc. of 95 per cent ethyl alcohol). This treatment is followed by a drop of concentrated sulphuric acid. If inulin is present a bright red color is evident at once and soon disappears. If the inulin is in the form of crystals the red color becomes evident as the crystals dissolve.

For class study, freehand sections are usually prepared and examined as temporary mounts, or they are mounted in glycerine jelly. These preparations are often unsatisfactory since beginning students have trouble finding the transparent crystals. Inulin crystals in glycerine jelly preparations often dissolve within a few months after mounting.

The following method has been devised for the preparation of permanent microscopic mounts with the inulin differentiated by its reddish pink color when stained with phloxine. Inulin crystals in tissues prepared by this method 10 years ago are as satisfactorily differentiated and brilliantly stained now as when made. The aniline blue counterstain has faded in these balsam mounts. It is probable that this fading of the counterstain can be counteracted to some extent by mounting in xylene clarite. Further tests with clarite as the mounting medium are in progress. Bismarck brown Y (certification No. CN-3) may be used as a counterstain instead of the aniline blue. It is much more permanent, but the color contrast is not as satisfactory as with the aniline blue. A saturated solution of Bismarck brown Y in 70 per cent ethyl alcohol may be used. Staining for 3 minutes gave the most satisfactory results.

Dandelion (*Leontodon taraxacum* L.) root is excellent as a source of tissue containing inulin. These roots should be collected during the summer or autumn. Roots collected during the winter period (January and February) have not proven satisfactory, apparently because of the low inulin content. Several fixatives have been tried, including formalin-acetic acid-alcohol and Carnoy's fluids. Dissolution of the inulin crystals occurred in all these fixatives. At length 70 per cent ethyl alcohol was resorted to as a killing agent, and at the same time causing crystallization of the inulin. Some plasmolysis of cortical cells occurred. However, this is of little importance since the preparation is intended as a food storage demonstration. Pieces of dandelion roots were cut into appropriate lengths and dropped into the alcohol. A faucet vacuum pump may be used to advantage in removing air from the tissues. Wittlake's (2) vacuum apparatus is ideal for this purpose.

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[1]Papers from the Department of Botany, The Ohio State University, No. 459.

The following schedule outlines the procedure in detail:

1. Use dandelion roots which are approximately 3/16" in diameter and cut into blocks of about the same length.
2. Place the pieces of root in 70 per cent ethyl alcohol (70 parts of 95 per cent ethyl alcohol to 25 parts distilled water).
3. Remove air from the tissues by a faucet vacuum pump. Allow the alcoholic treatment to continue about 72 hours after pumping, or longer if more convenient.
4. Complete the dehydration in 80, 95 and 100 per cent alcohols at intervals of 3 hours.
5. Transfer root pieces to ether-absolute ethyl alcohol (half and half mixture) for 3 hours.
6. Pass through a 2, 4, 6, 8, 10, 12, 14 and 16 per cent collodion[2] series at intervals of 24 hours, using the hot method of Wetmore (1).
7. Imbed in collodion on hardwood blocks and harden in chloroform for 12 hours.
8. Store in glycerine-alcohol (half glycerine to half 95 per cent ethyl alcohol) for 3 days or until needed.
9. Section on a sliding microtome. Good sections for general study may be made from 24 to 30 microns in thickness. The knife should be sharpened after cutting about 5 sections since the inulin crystals rapidly dull the edge. Keep the knife and tissue block flooded with the glycerine-alcohol mixture.
10. Transfer the sections to 95 per cent ethyl alcohol, rinsing 5 or 6 times to remove the glycerine.
11. Transfer to a half and half mixture of ether and absolute ethyl alcohol to remove the collodion.
12. Rinse in 95 per cent alcohol.
13. Stain in phloxine[3] (1 gram to 100 cc. of 90 per cent ethyl alcohol) for about 10 minutes.
14. Rinse sections in 95 per cent alcohol to remove the excess phloxine.
15. Counterstain in aniline blue (1 gram to 100 cc. of 95 per cent ethyl alcohol) for 15 to 30 seconds. Care must be taken to prevent overstaining in the aniline blue. The inulin should remain a pinkish red color. If the inulin crystals absorb too much of the blue stain, restain by transferring to the phloxine again.
16. Rinse in 95 per cent ethyl alcohol.
17. Transfer to absolute ethyl alcohol for 3 minutes.
18. Clear in xylene for 5 minutes. Wintergreen oil (methyl salicylate) may be used to advantage before the xylene treatment. This must be short, however, since it appears to intensify the aniline blue and to cause the inulin crystals to appear purplish.
19. Mount in neutral balsam, or in xylene clarite.

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(1) **Wetmore, R. H.** The use of collodion in botanical technic. Stain Tech., 7: 37–62. 1932.
(2) **Wittlake, Eugene B.** An efficient vacuum apparatus for microtechnic. Ohio Jour. Sci., 42: 65–69. 1942.

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[2]Collodion Cotton or Pyroxylin, prepared and sold by the J. T. Baker Chemical Co., Phillipsburg, N. J., is excellent and inexpensive for this purpose.

[3]The phloxine originally used was manufactured by Coleman and Bell, Norwood, Ohio. More recent tests have been made with phloxine from The National Aniline & Chemical Co., New York, N. Y., certification No. 9, total dye content 82 per cent.

A DEVICE FOR OBSERVING LIVING FISH EMBRYOS AT CONTROLLED TEMPERATURES

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In many species of fishes, living embryos together with their yolk sacs lie partially suspended within the perivitelline space. They rotate freely when the eggs are disturbed, but otherwise they assume a position of equilibrium in relation to the center of gravity. During cleavage stages, the early blastomeres and later the blastoderm at the animal pole are uppermost. During gastrulation, the center of gravity may shift as oil globules disappear or coalesce and the embryo grows forward from one side of the germ ring. As a result, before the hatching stage is reached, the embryo at different times may appear to be attached to the yolk at its side or below or above it.

Such changes in relative position of the fish embryo in relation to the yolk sac make desirable its observation through a microscope held in a horizontal position. At such an angle, the embryo may be viewed in profile against an illuminated background, rather than by reflected light against the yolk as a background. From the vertical position, the observation of cell boundaries of the superficial blastomeres and the topography of the relatively translucent embryo is not satisfactory.

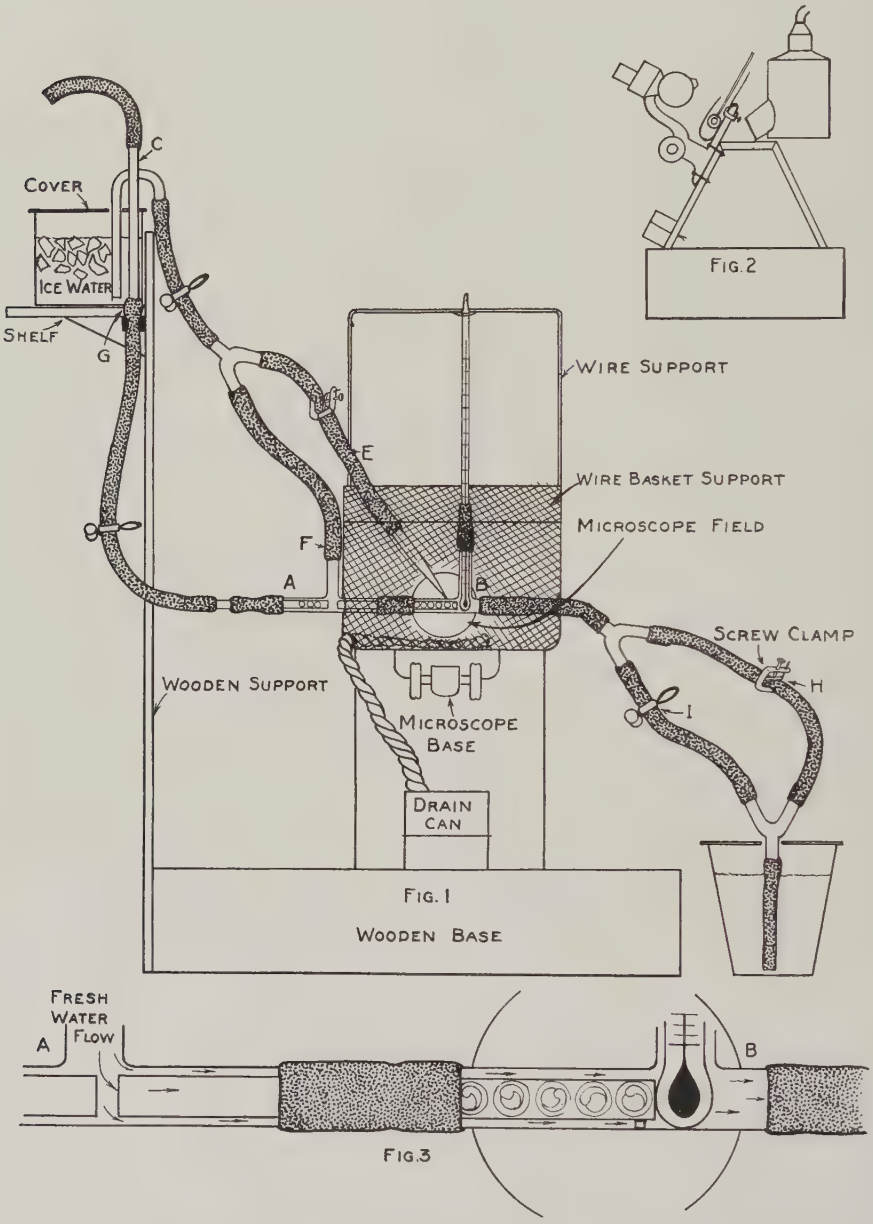
The device described below permits the observation of such embryos in profile from the side view, and at the same time under controlled temperature conditions.

The essential features of this apparatus, shown in the accompanying figures, include a series of glass tubes which convey non-adhesive fish eggs into the field of vision of a binocular dissecting microscope. The eggs are viewed from the side. A lighted background throws the blastodisc or embryo into bold relief. Prechilled water, flowing over these eggs at a controlled rate, makes possible the retention of temperatures below that of the surrounding air and provides an oxygen supply to the eggs while they are being examined.

The design of the apparatus is evident for the most part from the drawings of the front view (Fig. 1) the side view (Fig. 2) and the detail of the tubes that bring the eggs into the field of vision (Fig. 3). The box-like wooden base has four sides. From its front and rear sides rise standards at the angle desired to give a slight tilt to the microscope bolted to the front at the top (See Fig. 2). The U-base of the microscope projecting above the wooden base gives an anchorage to the wire basket support of the tubing and thermometer. A focusing lamp in its housing is mounted on a vertical rod behind the wire basket, and the flat top of the wooden frame permits the use of a liquid heat filter in front of the lamp housing.

The rubber tubing, the straight glass tubing and the Y- and T-tubes used are of standard laboratory design. Metal screw clamps at *E* and *H* are used for maintaining a controlled steady flow of water, while pinch clamps are used elsewhere to obtain an on and off effect. The two T-tubes between positions *A* and *B* in Figs. 1 and 3 are of such a size as to permit the insertion of the base of a thermometer at *B* and of two straight glass tubes at *A* which carry the eggs as desired into the field of vision at B. These inside tubes are just large enough to carry eggs freely in single file without their piling up. The thermometer bulb acts as a barrier to their further passage at *B*. The rubber tube which seals the union between the T-tube and the stem of the thermometer permits the thermometer to be drawn

slightly out of the T-tube sufficient to clear the end of the horizontal tube and permit the passage of eggs out of the system into the catch basin to the lower right, when the clamp at *I* is opened.



Figs. 1–3. Apparatus for observing living fish embryos at controlled temperatures. Figure 1 shows the front view; fig. 2, the side view; fig. 3, detail of tubes that convey eggs into the field of vision.

The temperature inside the egg chamber, *A–B*, is read directly from the thermometer at *B*. The wires of a thermocouple may be wrapped around the bulb of the thermometer and their free ends connected to a galvanometer. The writer made such thermocouple readings with a Leeds and Northrup potentiometer, but when these readings were found repeatedly to be in close agreement with those of the thermometer used, the thermocouple was dismounted.

Effective temperatures below that of the surrounding air are obtained by siphoning prechilled or ice water from the supply vessel at the upper left along the route *F*, *A–B*, *H*, to the catch basin at the lower right. As water enters the horizontal double tubing from *F*, it flows through both the inner tubing over the eggs and outside this tubing. At the point of water entrance, *A* in Fig. 3, it is essential to have an open joint in the inner tubing, permitting the entrance of water as shown. The rate of flow of water is controlled by regulating the screw clamp at *H*. Temperatures on the eggs at *B* are elevated by a decrease and are depressed by an increase in rate of water flow. A further depression of the temperature may be brought about by packing the wire basket with cracked ice. Waste water from the melted ice follows the wicking into the drain can. The moisture that collects on the outside of the egg-conveying tube when temperatures below the dew point are reached is flushed off by a steady flow of water onto that surface from the pipette *E* regulated by the screw clamp above it.

Eggs to be observed with this device are introduced into the system by removing the glass tube *C* from its lower connection at *G*, and using it as a siphon for drawing eggs from the incubation jar. This tube also should carry eggs in single file. This tube, once filled with eggs, is connected with the rubber tube and held vertically in a clamp at *G*. During this operation, the flow of ice water from the supply jar is momentarily checked by the pinch clamp above the main line at *F*. The pinch clamp below *G* is then opened and the eggs pass into the horizontal tubing. The two lengths of inside tubing at *A* are then held end to end by hand pressure, and the eggs are drawn into the observation area of the tube *A–B*, against the bulb of the thermometer at *B*.

Preliminary to the examination of eggs, certain adjustments must be made. These include the focusing of the lamp, the placement of its water filter, the filling of the wire basket with ice, and the regulation of the temperature at *B* as desired by starting the siphon flow of water and its regulation at the screw clamp *H*. In addition, the screw clamp above *E* is adjusted to produce a water film over the outside of the observation tube. Once these preliminary adjustments are made, a dozen or more eggs may be introduced. Since the tube *A–B* is free to be moved in the wire-basket frame, it can be shifted from left to right to permit the examination of a number of eggs simultaneously. Once examined, eggs may be released by elevating the thermometer bulb as described above, and additional eggs be brought into the field of vision.

This device, while undoubtedly still subject to considerable refinement, has proved especially helpful in bringing such eggs into a profile view for protracted periods of observation. It was developed as a means of enabling the writer to observe the chronological sequence in fish embryonic bodily movements that are characteristic of certain egg stages, and to study bloodflow and heart rhythm at given desired temperatures. For prolonged observation of fish embryos incubated at temperatures below that of the laboratory air, a continuous flow of fresh aerated water controlled as to temperature is desirable. The above device has been found to provide these conditions reasonably satisfactorily. It lends itself for use with non-adhesive fish eggs of different diameters, since the egg-conveying horizontal tube may be replaced by one of any desired diameter, within limits usually encountered in such material.

Historical Geology

The late Professor Charles Schuchert hoped to complete within his lifetime a truly comprehensive treatise on the historical geology of North America, although it now seems that three volumes, the second of which has just appeared, are to constitute his contribution. But what a monument to his life's devotion to stratigraphy and paleontology these will be,—truly the stratigrapher's *vade mecum*! This is no cold lexicon of stratigraphic units, but a warm synthesis of the ever more complex facts and inferences concerning the stratified rock record of this continent, based upon years of field work and digests, begun in 1904, of hundreds of geological books and papers. The first volume, appearing in 1935, dealt with the Antillean-Caribbean region, including the Gulf Coastal Plain area. The second volume, summarily reviewed here, covers the 30 eastern and central states, including Texas. The third volume, which the publishers assure us is well advanced in preparation, will discuss New England, the Maritime Provinces, the rest of eastern Canada, central and arctic Canada, the Arctic Archipelago, and Greenland, "together with the philosophical conclusions and paleogeographic maps." In his introduction to the second volume, Professor Schuchert bequeaths to his successors "the Cordilleran wonderland." Nor has he made any attempt to give pre-Cambrian local histories, or any of the Pleistocene.

The plan of the book is simple and direct: the stratigraphy of each state is considered separately, but each is related to its neighbors and stratigraphic province. They are grouped in eight sections, following an introductory chapter on stratigraphic terminology: (1) New York, the standard for correlation of the Ordovician, Silurian, and Devonian in the eastern and central United States,—"No more fossiliferous or better understood formations exist than those of New York"; (2) the eleven states lying across the Appalachian geosyncline beginning with Pennsylvania and New Jersey and extending down and around to Mississippi; (3) the Atlantic Coastal Plain; (4) the states athwart the Cincinnati geanticline; (5) the states conditioned by the Ozark dome; (6) Wisconsin and Minnesota; (7) the eastern plan states; and (8) the states north and west of the borderland Llanoria. After introductory remarks on the general geological relations of each section, there follow separate chapters on the states, each of which includes an historical résumé of geological work, the major structural features, and the stratigraphic sequence, the last being a detailed catalogue of the rock units, beginning with the oldest and including the course and date of the name, lithology, thickness, abundant references to significant literature (especially since 1910), important fossils, and correlations. The number of stratigraphic units thus treated is around 2500. Where significant stratigraphic breaks occur between formations, they are indicated and their meaning discussed. In spite of elimination of superfluous verbiage and employment of a standard set of abbreviations, the whole, as may be expected, forms an imposing volume. The three plates display portraits of leading American geologists; the 78 correlation charts and 123 figures, mostly geologic maps and sections, sharply focus stratigraphic relations.

There can be no criticism of this work as a whole,—there is no similar modern compendium of American stratigraphy treated from the standpoint of sequence and significance,—and its tremendous value to all geologists, at home and abroad, is at once apparent. There will be innumerable critics of special points: "He hasn't mentioned so-and-so's work in such-and-such county," "He has incorrectly quoted my results on the forams of this-and-that well," "Apparently he never saw the section on thus-and-so creek," and so on. No one can hope to bring together so much data without occasional nods, and to sift it without missing a few grains or even occasionally dropping a brick. Will any of the rest of us ever have the courage and fortitude to produce a comparable landmark in American geology? Probably not.—*J. W. Wells.*

Stratigraphy of the Eastern and Central United States, by Charles Schuchert. xvii—1013, 78 charts, 123 figs., 3 pls. New York, John Wiley and Sons, 1943. $15.00.

ON SOME AMERICAN AND ORIENTAL EARTHWORMS

PART I

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This article contains descriptions and notes on distributions of earthworms sent recently to the Zoology department of Ohio State University for identification. Included among this material is the first specimen of the large Indian earthworm, *Drawida grandis* (Bourne) 1886, that has been available for study since the species was first described; the first specimens of *Drawida* from the type locality of *D. barwelli* (Beddard) 1886 that have been examined since the erection of that species; several specimens of one or possibly two species of the little known Philippine genus *Plionogaster* and material belonging to new species of five Moniligastrid or Megascolecid genera, including five new species from the United States. Although specific identification of the Plionogasters is at present impossible, study of this material has enabled recognition of the nature of the excretory system which is of a mixed type with both meganephric and micronephric tubules, the meganephridia enteronephric and resembling those in *Lampito*.

In connection with the section on *Diplocardia*, attention is once again (*vide* Gates 1929*a* and *b*) directed to the fact that much work, even of the most elementary nature remains to be done on the earthworms of the United States. Very little is known of the earthworms in that portion of the country below the southern limit of glaciation where native species are most to be expected. It may be permissible to express a hope that if war, inflation or high taxation prevent continued organization of costly expeditions to distant tropic and arctic regions, American zoologists will turn their attention to their own front yards, for instance to Alabama, South Carolina, Tennessee, Kentucky, Virginia, Arkansas, Oklahoma and Kansas with no records of *Diplocardia* hitherto, Mississippi and Texas with one record each hitherto, Georgia with two records, North Carolina with four records. Even in those northern states where some work on distribution has been done (Illinois, Indiana and Ohio), the gross morphology of the earliest named species is so inadequately characterized that recognition of intrageneric relationships is difficult or impossible. Attention of those in museums and biological surveys is also directed to the fact that types of nine or ten of the few known endemics are in European museums, that types of other endemics were probably destroyed in the San Francisco earthquake, and that the location and condition of other types is unknown. With possibility of further destruction of types during the war and to provide reference material for local workers, series from all of the type localities should be collected at the earliest opportunity.

The writer is indebted to Prof. R. C. Osburn for the privileges of the Zoology department during the academic year 1940–41, and to Prof. W. M. Barrows for the collection and careful preservation of the Florida forms.

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[1]Visiting Professor in the Department of Zoology and Entomology of The Ohio State University, 1940–41.

Family MONILIGASTRIDAE

Genus Drawida Michaelsen 1900

Drawida bournei (Michaelsen) 1897

Material examined.—Slides from the U. S. Nat. Mus. with sagittal sections of a half portion of an anterior end of a specimen, presumably from Ceylon, presented to Prof. Frank Smith by Dr. W. Michaelsen.

Internal anatomy.—Gizzards appear to be in xv-xviii. Recognition of boundaries of the male funnel is difficult but the testes appear to be attached to an anterior portion of the funnel which is located immediately above the region of attachment to the testis sac of septum 9/10. The vas deferens is certainly looped in front of 9/10 (probably also behind 9/10) and passes into the anterior face of the prostate without first passing into the parietes. The prostate is a longitudinally ellipsoidal body sessile on the parietes. The spermathecal duct is slightly thickened in the parietes, the widened portion ovoidal with narrower end ectally. The oviducal funnel is continued dorsally on the septum to a point just above the aperture into the ovisac.

Remarks.—D. bournei is one of a group of forms with "muscular" prostates. The taxonomic status of each of these species except *D. grandis* is still unsettled. It is very doubtful if information of much importance in connection with these problems can be obtained from sections such as those of *D. bournei*. After study of that material and of sections of *Syngenodrilus lamuensis* Smith & Green 1919 and of the literature on other species known only from similarly prepared sections as well as of sections prepared by professional technicians the author is of the opinion that Stephenson (1923, p. 6) was quite correct as to the advisability of dissection in the study of unique types and limited series.

Drawida grandis (Bourne) 1886

Material examined.—Valley above dhobi quarter, 300 feet above town towards Government House, by dam, Ootacamund, South India, November 15, 1932, 1 anterior fragment (*ca.* 180 mm. long). G. E. Hutchinson per Dr. Grace Pickford.

External characteristics.—Diameter 11 mm. Pigment unrecognizable. Prostomium prolobous, segment i partially retracted into ii. Nephropores begin on iii, those of vii-ix slightly displaced dorsally, posteriorly in *cd*, not displaced on xii, apparently functional on x. Clitellar coloration unrecognizable. Setae are closely paired, *ab* and *cd* about equal, $aa < bc$. On viii the setae are one mm. from 7/8 and 4½ mm. from 8/9. Setae are located on the anterior halves of the segments throughout all of the fragment.

The spermathecal pore of one side is a transversely placed slit on 7/8 on *c*, with protuberant wrinkled margins. On the other side the pore is on the ventral face of a rather conical protuberance. The female pores are on 11/12, about on *b*. The male pores are transversely placed slits just lateral to *b*. No genital markings.

Internal anatomy.—Septa 5/6–8/9 are thickly muscular. Gizzards are in xix-xxiii, but with strongly marked muscularity of the oesophagus in xvii and xviii. The postgizzard portion of the oesophagus is bent into a U-shape with the concavity facing the left side, the inner wall provided with high vertical ridges crossed by longitudinal furrows. The intestine begins in xxxiv. No typhlosole.

The last pair of hearts is in ix. Paired commissures are present on the posterior faces of 8/9–9/10. The extra-oesophageals are lateral to the hearts. Nephridia are present in x.

The left testis sac is displaced behind the ovarian segment. The vas deferens is in a number of fairly long hairpin loops on the anterior face of 9/10 and more closely compacted, shorter loops on the posterior face but the total mass of the loops is much smaller than that of the testis sac. The ectal portion is iridescent and passes into the median face of the prostate close to the parietes. The prostate is disc-shaped, of circular outline, about 2½ mm. in diameter, sessile on the parietes, the duct slightly and gradually narrowed ectally within the

parietes, the greatest thickness more than half that of the prostate. The lumen of the prostate is a narrowly slit-like, horizontal cavity, the roof with three irregular ridges. On the center of the floor there is a tiny slit the margins of which are wrinkled, this portion possibly capable of protrusion through the male aperture as a sort of penis.

The spermathecal duct passes into the septum fairly high up in viii and deep in the parietes is slightly thickened, the atrial portion rather elongately top-shaped. The lumen of the duct remains narrow but has an irregular course through the greater portion of the length of the atrium, in the ectalmost portion abruptly widened and with irregular walls. In this portion there is a tiny conical protuberance. Segment xi is reduced to a horseshoe-shaped ovarian chamber. Ovisacs extend into xii or xiv.

Remarks.—Ovisacs are contracted, with thick walls, the lumen filled with a felted, dark brown material. There are no free ova in the ovarian chamber. Spermathecal ampullae are distended. The worm is probably in a late postsexual stage.

Drawida sp. 1

Material examined.—Valley above dhobi quarter, 300 feet above town towards Government House, by dam, Ootacamund, South India, November 15, 1932, 1 mature specimen. G. E. Hutchinson per Dr. Grace Pickford.

External characteristics.—Length 132 mm. Diameter 6 mm. Pigment unrecognizable. Prostomium prolobous, retracted under iii. Nephropores begin on iii, those of viii slightly displaced dorsally, not displaced on xii, apparently functional on x. Clitellar coloration unrecognizable. The setae are paired, *ab* and *cd* about equal, *aa* and *bc* about equal.

The spermathecal pores are transversely placed slits, not minute, on 7/8 in *cd*. Female pores are on the anteriormost margin of xii just lateral to *b*. Male pores are transversely placed slits on 10/11 just lateral to the seminal grooves and hence in the lateral half of *bc*. The grooves are longitudinally placed, rather irregular, clearly marked and fairly deep with slightly tumescent margins, extending across almost all of x and to the setal arc of xi, crossing 10/11 about at mid *bc*. No genital markings.

Internal anatomy.—Septa 5/6–8/9 are thickly muscular. Gizzards are in xvi-xxi, the one in xvi small. The intestine begins in the region of xxxi-xxxiii. Enterosegmental organs are present. No typhlosole.

The last pair of hearts is in ix. There is a pair of commissures on the anterior face of 8/9. Extraoesophageal trunks are lateral to the hearts. Nephridia are present in x.

The right testis sac is dislocated posteriorly, the left sac approximately equally in ix and x. The vas deferens is fairly long and looped on both sides of 9/10 but the mass of the loops is much less than that of the testis sac. No slender portion noted. The vas passes directly into the anterior face of the prostate near the ental end without first passing into the parietes. The prostates are rather ovoidal but with bluntly rounded ends, the ectal end broader, protuberant into the coelomic cavity to a height of two mm., leaning slightly mesially, the duct restricted to the parietes and on the median side of the ventral face of the gland. The glandular portion (coelomic) is in the form of a crescentic to U-shaped band of pink, coarsely granular appearance placed transversely across the prostate, reaching mesially and laterally nearly to the parietes, the anterior and posterior faces of the prostatic capsule smooth and bare. Internally the prostate is lined with a slightly pink, soft layer. The cavity is closed off ventrally and is eccentric due to the greater thickness of the floor. Into the transversely slit-like cavity within the body wall there is protuberant a rather indefinite, roughly conical but wrinkled bit of tissue, possibly a penis protrusible to the exterior through the male pore.

The spermathecal atrium is thickwalled, rather conical but with bluntly rounded dorsal surface, protuberant into the coelomic cavity of viii, directed posteriorly, smaller than the prostates. The spermathecal duct passes into the median face of the atrium somewhat below the ental end. The lumen is U-shaped in horizontal section due to the presence on the anterior wall of a vertical ridge. The ovarian segment is reduced to a horseshoe-shaped chamber. Ovisacs extend into xv.

Remarks.—Ovisacs are distended, yellowish and filled with ova but there are only a few loose ova in the ovarian chamber. Spermathecal ampullae are distended. Deferent ducts are slightly iridescent. The worm appears to have passed the peak of sexual activity.

Distinguished from *D. matthai* Michaelsen 1910 and *sulcata* Michaelsen 1907, the other species of the genus with seminal grooves, by characteristics of prostates and spermathecal atria of sufficient importance to warrant erection of a new species. The single specimen has been dissected too drastically to be of value as a type.

Drawida sp. 2

Material examined.—Manila, Philippine Islands, October, 3 juvenile specimens. Zacharias de Jesus per Prof. R. C. Osburn.

External characteristics.—Length to 75 mm. Diameter to 2½ mm. Unpigmented. Prostomium prolobous. Nephropores posterior to xii, when recognizable, are in *cd*, on viii slightly dorsal to *d*, still less so on vii and anteriorly, not seen on ix-xii. Setae begin on ii but are partly lacking as far back as x; on xx, $ab=cd$, $aa<bc$, *dd ca.* $=\frac{1}{2}$C but slightly greater posteriorly.

The spermathecal pores are transversely placed slits with slightly wrinkled margins on 7/8, on or just median to *c*. Female pores are on *b*, just behind 11/12. Male pores are transversely placed slits about in line with 10/11 on the ventral ends of conspicuously protuberant, columnar porophores seated across 10/11, slightly nearer to *c* than to *b*, the porophores not distinctly demarcated laterally and mesially but apparently reaching nearly to *b* and *c*, sharply demarcated anteriorly and posteriorly by transverse furrows, the portion belonging to xi probably slightly larger than that belonging to x.

Genital markings are a pair of longitudinally placed areas of elliptical outline and epidermal thickening, sharply demarcated, in the lateral half of *bc* on x, reaching anteroposteriorly nearly to 9/10 and 10/11. In addition there is just anterior and posterior to each male porophore a slightly depressed, indistinctly demarcated area of greyish translucence or especially homogeneous opacity.

Internal anatomy.—Septa 5/6–8/9 are thickly muscular. Gizzards are in xii-xiv (1), xiv-xvii (1), xv-xvii (1). The intestine begins in xxvi (1), xxvii (1), xxviii (1). No typhlosole.

The last pair of hearts is in ix (3). There are paired, vertical commissures on the posterior faces of 8/9 and 9/10. Extra-oesophageal trunks are lateral to the hearts. Nephridia are on the posterior faces of the septa and reach up to the dorsal blood vessel. Preseptal funnels are close to the ventral parietes in the region of *ab*. Nephridia apparently are lacking in x.

The testis sacs are constricted by 9/10 with approximately equal portions in ix and x. The vas deferens is very short, without loops in ix where it passes around the heart, with several loose hairpin loops in x, passing directly into the anteromedian aspect of the prostate slightly above the parietes without first passing into the body wall (3). The prostates are sessile on the parietes, the capsule whitish, top-shaped, an almost spheroidal portion sessile on the body wall, an antero-posteriorly flattened duct within the parietes. The lumen is transversely slit-like in horizontal section. The prostates may be slightly bent over mesially or anteromesially.

Segment xi is reduced to a horseshoe-shaped ovarian chamber (2 largest specimens). Ovisacs, even in the largest worm, are juvenile. There are no spermathecal atria nor is there any recognizable enlargement of the duct within the parietes.

Remarks.—Testis sacs are well developed in all three specimens. In the smallest worm the spermathecal ampullae are just recognizable as slight widenings of the ental ends of the spermathecal ducts, and ovisacs do not reach across xii. In the other worms the spermathecal ampullae are filled with whitish material but the ovisacs which extend into xiv are still juvenile. The vas deferens is of about the same length in all three specimens. Except for the ovisacs sex organs appear to be fully developed.

Manila is the type locality of *D. barwelli* (Beddard) 1886 but little of taxonomic value is known of that species (*vide* Gates 1937).

Genus Desmogaster Rosa 1890

Desmogaster ferina sp. nov.

Material examined.—Beneath brookside log, Tingpai, Myitkyina district, Burma, November, 1 juvenile and 1 larger, possibly fully grown specimen. F. D. Forbes.

External characteristics.—Length 137–171 mm. Diameter 4–5 mm. Unpigmented. Each specimen is coiled in a rather spiral fashion and is dorsoventrally flattened except for a short anterior region. Prostomium prolobous. Secondary annulation begins on v (2), one deep, presetal secondary furrow present on each of segments v-xii.

Setae are lacking on the anteriormost segments, beginning on ix on the smaller specimen where only *c* and *d* of the left side are lacking, on x of the larger worm where both couples of the left side are lacking, and are small, closely paired, *ab* and *cd* about equal, *aa* much larger than *bc*, *dd* probably slightly greater than ½C. On one or two segments anterior to x or ix a transversely placed, greyish translucent line at the approximate sites of the ventral couples is visible.

Nephropores, when visible, are on the anterior margins of the segments, in *bc*, the location variable, nearer *b*, at mid *bc*, or nearer to *c*.

Bithecal, the spermathecal apertures represented, on the larger specimen, by minute, circular pores on 8/9, about on *c*. The male pores are small, transversely placed slits on 11/12 and 12/13, slightly median to *c*. Female apertures are transversely placed slits on xiv, quite definitely behind 13/14 and slightly lateral to *b*.

Internal anatomy.—Septa 5/6–9/10 are thickly muscular, funnel-shaped, apices directed posteriorly.

Gizzards are six in xx-xxv or seven in xx-xxvi.

Extra-oesophageal trunks are first recognizable in v from whence they pass posteriorly just lateral to the hearts and into the subneural vessel in xvi. Anterior to this junction the subneural is very slender and recognizable for only a short distance. On the posterior faces of 10/11 and 11/12 there are commissures from the extra-oesophageal trunks to the dorsal vessel. The last pair of hearts is in xi (2). Hearts or heartlike commissures are present in v-x but those of v-vii have not been traced to the ventral trunk.

Nephridia are present from iv posteriorly, the ducts, in the postgenital segments at least, passing into the parietes just behind the septa in the region of *ab*.

Paired testis sacs are present in the usual locations, in 10/11 and 11/12. The vas deferens is short, and drops directly, without any real looping, to the ventral parietes into which it enters just behind the septum, in *ab*. The prostates are bent over mesially or medioposteriorly in xi and xii, elliptical in cross section, about two mm. long (in the larger worm), the ental end bluntly rounded. In cross sections two canals are visible, one central or nearly so and slitlike to shortly elliptical, the other much smaller, eccentric and more nearly circular.

Segment xiii is reduced to a horseshoe-shaped ovarian chamber (2). The right ovisac of the larger worm is lateromesially flattened and reaches into xx. The spermathecal ampullae are fairly large, flattened discs, about 1½ mm. in diameter, with heart-shaped outline, on the posterior face of 8/9, the entalmost portion of the duct located in the ventral notch very slightly thickened. Underneath the ampulla the duct is in several hairpin loops, an ectal portion of the duct within septum 8/9. The duct is not widened within the septum or parietes and there is no atrium.

Remarks.—The larger specimen with an ovisac extending into xx may be of adult size but the ovarian chamber and the ovisacs contain no free ova, indicating that sexual maturity has not been attained. Both testis sacs of the left side and the right posterior sac are dislocated to positions behind the ovarian chamber and median to the ovisacs. The absence of ovisacs, as well as the small size of the other reproductive organs, proves the juvenile condition of the second specimen.

The prostate is actually an elongate, hairpin loop of the vas deferens, the two limbs of the loop enclosed in a common sheath or sheaths, the ectal limb of the loop slightly thickened.

D. ferina is distinguished from *D. planata* Gates Gates 1931 by the absence of spermathecae in viii, from *D. doriae* Rosa 1890 by the location of the spermathecae in ix, and from *D. albalabia* Gates 1930 by the absence of spermathecae in viii and the erect prostates. In absence of clitellate individuals or specimens known to be fully adult a satisfactory diagnosis cannot be given.

Family GLOSSOSCOLECIDAE

Genus PONTOSCOLEX Schmarda 1861

Pontoscolex corethrurus (Fr. Müller) 1857

Material examined.—Manila, Philippine Islands, October, 13 juvenile and 14 clitellate specimens. Zacharias de Jesus per Prof. R. C. Osburn.

External characteristics.—The first setigerous segment is not recognizably marked off from a peristomium (which may be retracted) but is long and with the setae located nearer the posterior margin. In segmental enumerations the second setigerous segment is assumed to be iii. The anterior segments are strongly contracted so that nephropores are first visible on vi, and from there posteriorly about on *c*. The clitellum extends from an anterior portion of xv (9) or a posterior portion (5) onto xxiii (14).

Spermathecal pores are minute, in line with the nephropores, on 6/7–8/9 but are unrecognizable until after spermathecal ducts have been dissected out from the parietes. Female pores apparently are on 14/15, median to *a* but closer to *a* than to each other (1 specimen only). Male pores are unrecognizable.

Thickened "ridges" or "walls" are unrecognizable but on xix-xxii, on each side, just inside the median portion of *bc*, there is a clearly marked, slightly depressed, greyish translucent line with an appearance of a seminal groove, the line bent slightly mesially on the posterior half of xix and the anterior half of xxii so that the setal arcs of those segments are not quite reached (14).

Internal anatomy.—Septa apparently are lacking anterior to 5/6 (note location of nephridia of ii-v), 5/6 transparent and attached to the gut just in front of the gizzard; 6/7–9/10 funnel shaped, apices posteriorly; 9/10 displaced posteriorly and attached to the parietes directly over site of intersegmental furrow 10/11; 10/11–13/14 very delicate and displaced posteriorly.

The gizzard is in vi (14). Calciferous sacs are flattened, leaf-shaped bodies in vii-ix (14), the ducts passing to the gut dorsolaterally just in front of the septae. Intestinal origin probably in xiv or xv. The typhlosole begins abruptly in the region of xxv and is a simple lamella but with the height (2 mm.+) greater than the diameter of the gut so that the lamella is folded. The typhlosole ends abruptly 15–20 mm. from the hind end.

The dorsal blood vessel (single) is continued anteriorly to the pharyngeal region, deeply constricted behind 9/10 in such a way as to mark off eight to ten spheroidal sections, this portion of the trunk bent into an S-shaped figure and thus adding to the difficulties involved in determination of septal relationships. A supra-oesophageal trunk is recognizable only in x-xii or xiii. Extra-oesophageals are large in vi and filled with blood but elsewhere are empty, apparently passing ventrally on the anterior face of 5/6 and then turning mesially to unite under the gut. What appear to be posterior continuations of the trunks are close to or on the gut from vii posteriorly, in the region of ix-xiii at least, represented only by a median vessel on the ventral face of the gut. The subneural trunk is larger than the ventral vessel and looped with closed ends of the loops projecting out beyond the nerve cord. A pair of large branches in xii pass upwards to the supra-oesophageal but the trunk is continued anteriorly at least to 9/10. One or two other pairs of large vessels from the subneural have not been traced. In xii-xiii (?) four large vessels, apparently from the united extra-oesophageals, pass up from the gut to the supra-oesophageal. There are two pairs of hearts posterior to 9/10 (14) presumably

of x-xi, all of which open into the supra-oesophageal. Connections to the dorsal trunk not found.

From x forwards nephridia are on the anterior faces of the septa, nephridia of iii-v on the anterior face of 5/6 but identifiable by the ducts which pass forwards and into the body wall at the usual positions in iii-v. Nephridia of ii are represented apparently by a large cluster of tubules on each side filling the space in front of 5/6 between the gut and the body wall. In each cluster is a large duct with two long, hairpin loops, which then passes anteriorly close to the ventral parietes and about in region of ii upwards into the gut. Nephridial funnels in the postclitellar segments are preseptal, close to the ventral parietes median to *a*, markedly scoop-shaped, the back of the scoop continued into two prongs. Anteriorly funnels have not been found.

Testes and male funnels are in two fairly widely separated and longitudinally directed, suboesophageal testis sacs so placed that the ovaries are just beneath the posterior ends. The hearts of xi apparently are included within the testis sacs which are filled or nearly filled (when small amounts of coagulum are present) by large, accordion-pleated frills (peripheral portions of male funnels?). On the floor and at the center of the sac is a rounded, button-like structure with a central depression which is probably the aperture of the funnel. From a point just in front of this aperture the male deferent duct drops to the parietes and then passes laterally for a short distance before turning to run posteriorly in the median part of *bc*, visible as far back as xvi or xvii before passing out of sight in the parietes.

The ovaries are unusually small. The oviducal funnels are flattened and very thin discs rather high up on the anterior face of 13/14, the oviducts unusually long but passing straight anteroventrally along the septum to the parietes.

Remarks.—In spite of the ubiquity of this species in the tropics and the frequent reports of its occurrence several questions as to gross morphology are still unanswered. The major difficulty is that of determination of segmental location of structures and this is due in part to the apparent absence of the first intersegmental furrow, the small size of the setae on the first setigerous segment, the dislocation posteriorly of certain septa, the small size and concealed location of the ovaries. The location of septum 9/10 over site of intersegmental furrow 10/11 is at first confusing but inspection of the inner surface of the parietes reveals quite clearly two segments between the parietal attachments of the last muscular septum and of the septum next in front. This presumably is the explanation for Stephenson's failure to find 9/10 (1923, p. 490). However in front of the last muscular septum there is only one pair of nephridia and one pair of vascular commissures while the attachments to the gut of the last calciferous sacs, supposedly of ix, are just in front of the last muscular septum, conditions which arouse a suspicion that 9/10 is not lacking but merely displaced posteriorly. The suspicion is strengthened on tracing the ducts of the nephridia, for each duct after dropping to the ventral parietes passes across *two* segments almost to 8/9. The final confirmation of the dislocation of 9/10 is provided by the ducts of the nephridia next behind the last muscular septum, the ducts passing on the parietes and underneath 9/10 and onwards under very delicate connective tissue to points just behind the site of intersegmental furrow 9/10. According to Michaelsen (1900, p. 425) 10/11 is thickened but in each of the Manila specimens that septum is just as tenuous and transparent as those next behind.

Oviducts were noted in one specimen only and in that worm were large enough so that they could be dissected out from the body wall. Only then were the female pores recognizable. The location on 14/15 is unusual and may be an abnormality.

(The use of "apparently," or similar phraseology, in the account above is regretted but the word concisely characterizes appearances, and nothing further is justifiable in view of the condition.)

Septal relationships as regards segments x-xv, the segment of intestinal origin, some of the relationships of the major blood vessels and the location of the female pores need confirmation or more accurate characterization.

Genus Sparganophilus Benham 1892

Sparganophilus eiseni Smith 1895

Material examined.—Roadside ditch, Yellow Fern Creek, Fort Myers, Florida, January 21, 1941, 11 aclitellate specimens. Prof. W. M. Barrows.

Roadside ditch, Fort Myers, Florida, February 19, 1941, 11 aclitellate and 3 clitellate specimens. Prof. W. M. Barrows.

External characteristics.—Length 80–85 mm. (clitellate specimens). Diameter 1½ mm. in clitellar region, 1¼ mm. elsewhere. Unpigmented. Anterior ends not hooked. Prostomium zygolobous (20). No dorsal pores recognizable but a longitudinal grey streak along the mid-dorsal line crosses i-iii to 3/4 or slightly onto iv, the streak slightly widened at intersegmental furrows and there with an appearance somewhat like that of rudimentary dorsal pores. Setae begin on ii, dorsal couples lacking on xvi-xxiv (3 clitellate and 6 aclitellate specimens), in part lacking or unrecognizable on the same segments of several other specimens. Behind the clitellum *ab* is slightly smaller than *cd*, *dd* and *bc* about equal and both larger than *aa*. Nephropores are invisible but sites are indicated by tiny, white, circular spots on or slightly lateral to *a*, about midway between intersegmental furrows and setal arcs.

The clitellum is rather grey, saddle-shaped, lacking in *bb*, anterior and posterior limits unrecognizable externally, xvi-xxiv included (3) and part at least of xv (1) and xxv (2) or xxv-xxvi (1) as indicated by the epidermal thickening at the mid-dorsal incision. The clitellar region is protuberant especially so at xix-xxi. Tubercula pubertatis are represented by longitudinal white bands (not protuberant) extending from or just behind the setal arc of xviii to 23/24 in the median half of *bc*, the margins, especially the lateral, sinuous (3).

The spermathecal pores are on 6/7–8/9 on *c* (3), the left pore of 8/9 quite definitely below *c* on one specimen. Female pores are on xiv, on or just lateral to *a* and about midway between 13/14 and the setal arc. Male pores are unrecognizable. Apertures of the prostate-like glands are minute, on the ventral faces of tiny, nearly spheroidal, whitish protuberances located slightly posterolateral to the *b* setae of xvi-xvii and xxiv-xxvii (3 clitellate and several aclitellate specimens). On two of the clitellate specimens a circular area including the right *a* seta of ix is slightly tumescent but the only pore recognizable is the aperture of the setal follicle.

Internal anatomy.—No gizzard. An oesophageal valve is unrecognizable, the intestine apparently beginning with 8/9 or posteriorly in viii. No typhlosole.

The dorsal blood vessel (single) is continued anteriorly into ii, with moniliform hearts in vii-xi (7) and slender commissures in iii-vi. No subneural. Lateroparietal trunks are recognizable in vi-xiv, turning mesially just in front of 14/15, uniting on the upper surface of the ventral trunk and then disappearing from view (3, opening into ventral trunk?). On the parietes in xii-xiv just lateral to each lateroparietal trunk is a smaller vessel which turns upwards on the anterior face of 14/15 to open into the dorsal trunk.

Nephridia are present in xiii (14), lacking in xiv (14), present from xv posteriorly, the preseptal funnels close to the ventral parietes in *ab*.

Seminal vesicles of xi and xii are acinous with scattered brown flecks. The prostate-like glands of xxiv-xxvii are shortly and regularly looped in a rather zigzagged manner, the ducts straight, slender and with slight (muscular?) sheen. Glands in xvi-xvii usually are not looped but are arced. The gland of ix (right side only, two clitellate specimens) is fairly large and of irregular shape.

Remarks.—Spermathecae, present only in the clitellate specimens, appear to be juvenile, ampullae slightly developed in one worm only. There is no iridescence on male funnels or in the deferent ducts. Seminal vesicles and ovisacs are of about the same size and appearance in the clitellate and larger aclitellate specimens. In one of the clitellate worms the free extremity of one ovary passes through an aperture in 13/14 into the ovisac of the same side.

According to Hague (1923, p. 22) the prostate-like glands of *eiseni* usually open to the exterior through the follicles of the *b* setae, while in *benhami* Eisen 1896, according to Eisen, the apertures are anterior to *ab*. In the Fort Myers worms the pores are invariably posterolateral to *b*.

Hague has suppressed *benhami* with varieties *guatemalensis* and *carnea*. Possibly the taxonomy of the Sparganophilids of the United States requires reconsideration.

Family LUMBRICIDAE

Genus EISENIA Malmgren 1877

Eisenia foetida (Savigny) 1826

Material examined.—New Orleans, Louisiana, December 15, 1940, 2 clitellate specimens. E. Liebman.

Campus, Johns Hopkins University, October, 1940, 4 clitellate specimens. Per Prof. S. O. Mast.

November, 1940, 2 aclitellate and 16 clitellate specimens (history unknown). Prof. W. M. Barrows.

Ohio division, California Earthworm Farms, Worthington, Ohio, January 10, 1941, 3 partially clitellate and 24 clitellate specimens. Per E. Gordon.

"Soilution earthworms," purchased from California Earthworm Farms, Los Angeles, California, December 30, 1940, 27 juvenile or aclitellate (and in part postsexual) and 42 clitellate specimens. Per E. Hoffman.

External characteristics.—The Johns Hopkins worms are small, 27–30 mm. long, though apparently complete and fully grown. The "soilution" worms may attain a length of 60 mm. and a diameter of five mm. Except under the highest powers of the binocular, the Johns Hopkins worms appear to be characterized by a uniform, dark red pigmentation without striping. Only 13 of the "soilution" worms have a conspicuous striping, on the other specimens the striping faint or quite unrecognizable. The prostomium is epilobous, *ca.* ½, a transverse furrow at the posterior end of the tongue usually lacking or if present slight and rather irregular. The first dorsal pore is on 4/5 (48), on 5/6 but with a definitely pore-like and possibly functional marking on 4/5 (3). Nephropores usually are unrecognizable but on several specimens pore-like markings are visible on xv and xvi halfway between *b* and mid *bc*.

The female pore is minute, on the setal arc of xiv, just lateral to *b*. The male pore is minute, on the setal arc of xv, about midway between *b* and *c*, often at the lateral end of a fairly deep, transverse slit with tumescent borders. Spermathecal pores are smaller than the male and female pores, on 9/10 and 10/11, slightly lateral to the mid-dorsal line. Pores may be symmetrically or asymmetrically placed with reference to the mid-dorsal line. If symmetrical, apertures of either pair may be slightly more widely separated than those of the other pair.

Clitellar margins (anterior, posterior and ventral) are often rather indistinct. Slight clitellar thickening of the epidermis anteriorly and posteriorly beyond the apparent (external) limits may be recognizable at the middorsal incision. The clitellum is located as follows: on xxv-xxxi (1), xxv-xxxii (1), xxvi-xxxi (9), xxvi-xxxii (52), xxvi-xxxii but reaching slightly onto xxv (1), xxvi-xxxii but reaching slightly onto xxxiii (3), xxvii-xxxii (4), xxvii-xxxiv (1).

Tubercula pubertatis are rather indistinct and boundaries are often difficult of recognition. Usually the tubercula appear to be of a rather narrowly elliptical outline and are longitudinally placed in the median half of *bc* with the median margins slightly lateral to *b*. A central portion, also of elliptical outline, is slightly more translucent than the rather wide, slightly tumescent and opaque, marginal portion. Tubercula pubertatis are located as follows: xxvii-xxx (1), xxviii-xxx (48), xxviii (postsetal half) -xxxi (presetal half)—23, xxviii (postsetal half) -xxxii (presetal half)—1, xxix-xxxi (3).

A variable number of the ventral setae in the clitellar region, and occasionally on one or two segments just in front of the clitellum, appear to be located each within an area of greyish translucence. Under highest powers of the binocular there is clearly recognizable just behind each of such setae a small, transversely placed, translucent marking of spindle or crescent shape. On such a marking there may be recognizable a single, minute spot with an appearance of a pore. If setae are carefully pulled out of the body wall from the interior after opening

the worm, the anterior location of the aperture of the setal follicle, quite definitely in front of the marking, is clearly recognizable.

Local areas of tumescence extending across the whole of certain segments may have somewhat of an appearance of genital markings but never seem to be sharply demarcated. These areas are most commonly present on ix-xii in region of *cd* but have been noted on ix (2), xxi (2), xxii (1), or xxiii (2), in *ab*. An area around the male pore and in a median portion of *bc* is usually more or less markedly tumescent but the swelling may be entirely lacking on fully clitellate specimens with spermatozoal iridescence in the spermathecal ampullae.

Flattened discs are occasionally adherent to the body in intersegmental grooves: 20/21, in *bc* (1); 21/22, in *aa* (2), in *ab* (2), in *bc* (4); 22/23, in *aa* (1), in *bc* (4); 23/24, in *aa* (2), in *bc* (1); 24/25, in *aa* (1), in *bc* (1). The outline of the disc approximates to circular or pear-shaped. The peripheral portion is transparent, a central mass opaque and with an appearance of closely packed fibrils.

Internal anatomy.—There are no sacs on the oesophagus in x (20). Calciferous glands are in xi-xii. On each side of the oesophagus in xii there is a vertically placed, rather shortly hemi-ellipsoidal, white swelling, the white appearance due to presence in the calciferous glands of considerable masses of fine granules. The intestine begins in xv (20). The gizzard is located in xvii-xviii (20). The wall of the gut in xix is usually whitened and similar in superficial appearance to the gizzard.

The simple, lamellar typhlosole which begins gradually in the region of xx-xxiii, does not attain full height for several segments and ends abruptly, in lxxxix (worm of 100 segments), xcii (worm with 103 segments), or ciii (specimen with 117 segments). The lumen is vertically slit-like in cross section. In one or more small regions or along a considerable portion the ventral margin may be slightly furrowed longitudinally so that the typhlosolar lumen is rather Y-shaped (inverted) in cross section.

Five pairs of lateral hearts are present in vii-xi (20). In xii, opening into the dorsal trunk, there are two pairs of vessels which may be large, the posterior vessels resembling hearts but closely applied to the gut and gradually disappearing from view ventrally. A subneural trunk is present (20).

Seminal vesicles are four pairs, in ix-xii (20), those in ix-x usually about half the size of the others. Segments x-xi are usually filled with a testicular coagulum.

Spermathecal ampullae are usually in ix and x (19). In one specimen an ampulla is sharply constricted by 10/11, with one half each in x and xi. In another worm the left anterior ampulla is in x. One spermatheca is completely bifurcated entally, each ampulla containing a mass of spermatozoa.

Corresponding to each of the small, postsetal genital markings and closely associated with a setal follicle there is protuberant into the coelomic cavity from the parietes a soft gland so fragile that it usually fragments on manipulation, releasing a flocculent coagulum.

Remarks.—In one worm each seminal vesicle of ix-xii contains masses of brownish material similar to that forming the discs often present in the coelomic cavities. Another specimen has brownish material in the vesicles of xi and xii and several brown bodies or discs free in the coelomic cavity of xi.

Eisenia veneta (Rosa) 1896

F. *hortensis* Michaelsen 1890

Material examined.—"Found in toilet bowl," Cleveland, Ohio, April, 1941, 1 clitellate specimen. E. R. Miller per Prof. W. M. Barrows.

External characteristics.—Length 23 mm. Diameter 3 mm. Dorsum reddish anterior to clitellum. Behind the clitellum the body is markedly flattened dorsoventrally. Prostomium apparently prolobous but this appearance may be due to local contraction at the region of junction of prostomium and i. The first dorsal pore is on 5/6. Setae begin on ii, behind the clitellum *ab* and *cd* about equal though rather widely separated, $bc < aa$, $dd < \frac{1}{2}C$.

The protuberant clitellum extends from 26/27 to 32/33 laterally but dorsally xxxiii is included (*dd* only), the anterior and posterior limits sharply marked, the ventral boundary hardly recognizable. Tubercula pubertatis are on xxx-xxxi and the presetal portion of xxxii, well within median half of *bc* and reaching slightly into *ab* with *b* included and near the median margin, sharply demarcated, protuberant—especially so laterally, the margins slightly incised at 30/31 and perhaps indicating a double origin.

Spermathecal pores are on 9/10 and 10/11, slightly lateral to the mid-dorsal line. Female pores are on the setal arc of xiv slightly lateral to *b*. Male pores are in transversely slit-like depressions on the setal arc of xv and are quite definitely nearer to *b* than to *c*.

Internal anatomy.—The oesophagus is widened abruptly in the posterior portion of x but no sacs are recognizable. Longitudinal lamellae in xi-xiii are covered over mesially by a delicate and transparent film possibly representing the median wall of calciferous glands. The intestine begins in xv. The gizzard is in xvii-xviii. The typhlosole which begins in xx is low and of the simple, lamellar type. Last hearts in xi.

Male funnels are large, reaching to the level of the dorsal surface of the gut, and with a brilliant spermatozoal iridescence. In addition to the usual seminal vesicles in xi and xii there is a single, smaller vesicle in ix on the left side. Spermathecae are in ix and x, the ampullae filled with iridescent material, slender ducts and ampullae of about the same length.

Protuberant into the coelomic cavities from the parietes over the tubercula pubertatis are glandular masses just median to which are hypertrophied follicles of the *b* setae of xxx and xxxi. The setae are nearly straight, without nodulus, the extreme ental end portions slightly curved, the tips sharply pointed, an ectal portion grooved. No ornamentation.

Remarks.—The gut is somewhat macerated. In the intestine among the soil particles is a well rounded, almost spheroidal bit of quartz just over one mm. in diameter.

E. veneta is a European form and has been recorded but twice before from North America: San Francisco and Urbana, Illinois. Smith (1924, p. 26) found it in large numbers in banks of streams and it is presumably from some such habitat that the Cleveland specimen got into the water supply.

Genus Bimastos Moore 1893

Bimastos tenuis (Eisen) 1874

Material examined.—Sand pasture, Manitoulin Island, Ontario, August 13, 1940, 1 aclitellate and 2 clitellate specimens. C. H. Kennedy per Prof. R. C. Osburn.

External characteristics.—Length 20–27 mm. Diameter across clitellum, three mm. The dorsum anterior to the clitellum is red. Setae *a* and *b* of xvi are enlarged, the follicles conspicuously protuberant into the coelomic cavity just behind a glandular mass. All of the setae examined, except one, are sigmoid but with the nodulus about one third the distance of the shaft from the ental end. The exceptional seta is almost straight, no ornamentation recognizable.

Spermathecal apertures are minute openings on 9/10, on *c*. The female pores are very slightly posterolateral to *b*. Each male pore is within and close to the lateral margin of a transversely placed, slit-like depression located in an area of tumescence. A transversely placed area on xv and xvi just lateral to *b* is swollen and whitened but without distinct demarcation.

Tubercula pubertatis are small, slightly tumescent, whitened areas of approximately circular outline, with centers about on the *b* line and reaching slightly into *ab*, the *b* setae of xxix and xxx very slightly displaced mesially.

Internal anatomy.—Calciferous pouches are vertically ellipsoidal bodies in the posterior portion of x, clearly marked off from the gut but without stalks, opening into the gut through vertically slit-like apertures the margins of which are in apposition. A low typhlosole is present.

The male deferent ducts of a side pass laterally to the region of *c* and come into contact in xii, passing posteriorly on the parietes to the anterolateral corner of a flat glandular mass with a longitudinally rectangular outline, sessile on the parietes in xiv-xvi, in a median portion of *bc*. Other glandular masses of approximately circular outline are sessile on the parietes over the tubercula pubertatis.

Spermathecae have a spheroidal ampulla and a slender duct with the length about equal to the diameter of the ampula.

Remarks.—Specimens are too soft to permit determination of typhlosolar characteristics. Calciferous sacs of x are filled with clumps of white granules. Because of the stickiness of the glandular material the course of the male deferent ducts has not been completely traced but it appears to be posteromesially within the gland. Ducts are slightly iridescent, fairly large, on rather than within the parietes and hence easy to trace. Removal of nephridia is necessary for observation of the genital marking glands and enlarged setal follicles. One specimen has a single spermatheca on the left side, another worm has a pair.

A non-sexual worm collected along the Chesapeake and Ohio Canal near the District of Columbia line by Slatin and forwarded by the U. S. National Museum may be *tenuis*. There are only two pairs of seminal vesicles and spermathecae are lacking. The region of xxvi-xxxi is contracted in a regularly concave fashion and has an appearance like that of a clitellar region towards the end of clitellar regression. The digestive system is macerated, the oesophageal wall practically transparent. In xi-xiii there are clearly recognizable, without opening the gut, two series of thin but rather conspicuous lamellae. Each lamella of the first series is longitudinally rectangular in shape, extending through xi-xii without constriction. Lamellae of the second series are almost square and in xiii, separated from the anterior series by an interval in which lamella are quite lacking. Lamellae are discrete and without evidence of marginal fusion internally (*i. e.*, towards center of gut). This condition (of discrete lamellae) presumably is a result of maceration.